PROCEEDINGS.

OF THE

AMERICAN PHILOSOPHICAL SOCIETY.

HELD AT PHILADELPHIA FOR PROMOTING USEFUL KNOWLEDGE.

VOL. XIV. JUNE TO DECEMBER, 1874. No. 93.

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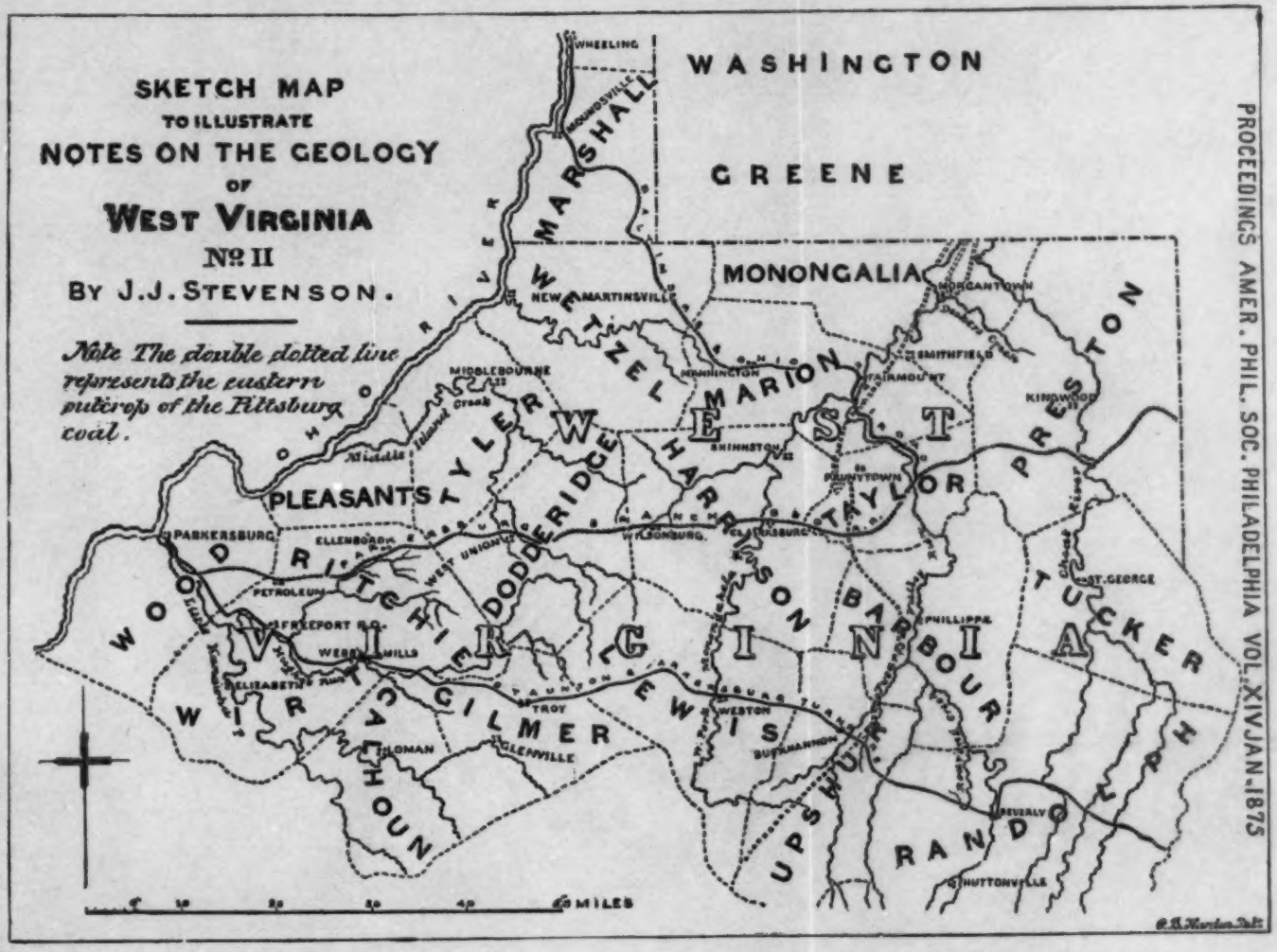

PROCEEDINGS AMER. PHIL. SOC. PHILADELPHIA VOL. XIV JAN. 1875

SHINGTON
REENE
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MORGANTOWN
SMITHFIELD
KINGWOOD
PRESTON
TAYLOR
ST. GEORGE
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PHILIPPI
BARBOUR
RANDOLPH
BEVERLY
HUTTONVILLE

Pl. I.

Fig. 1.

Fig. 2.

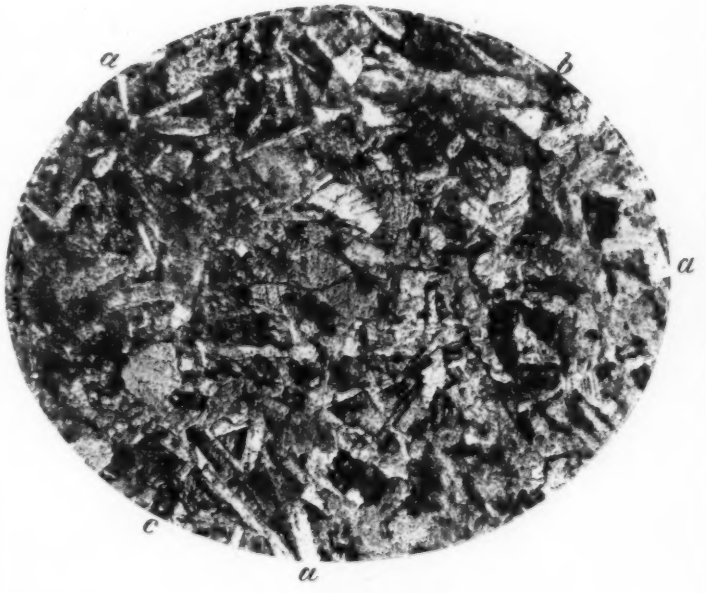

PHOTO-ZINCOGRAPH, by E. A. WENDEROTH & CO., 1025 Chestnut Street, Philada.

Pl. II.

Fig. 1.

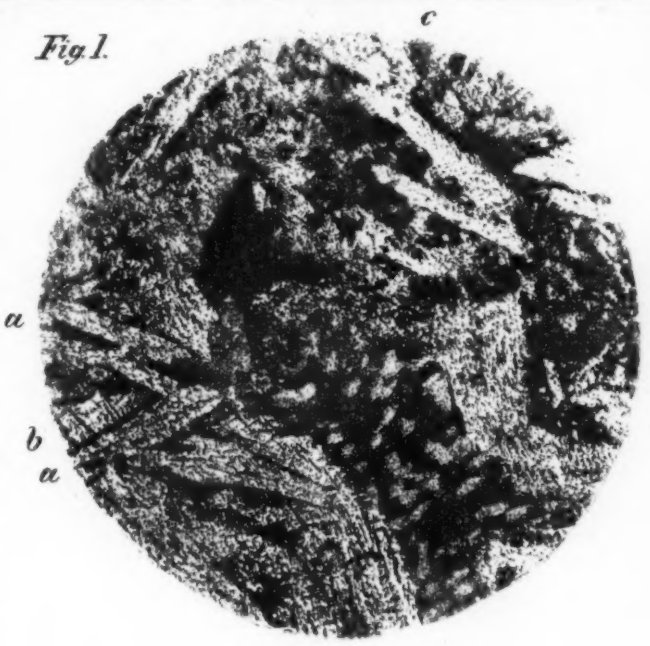

Fig. 2.

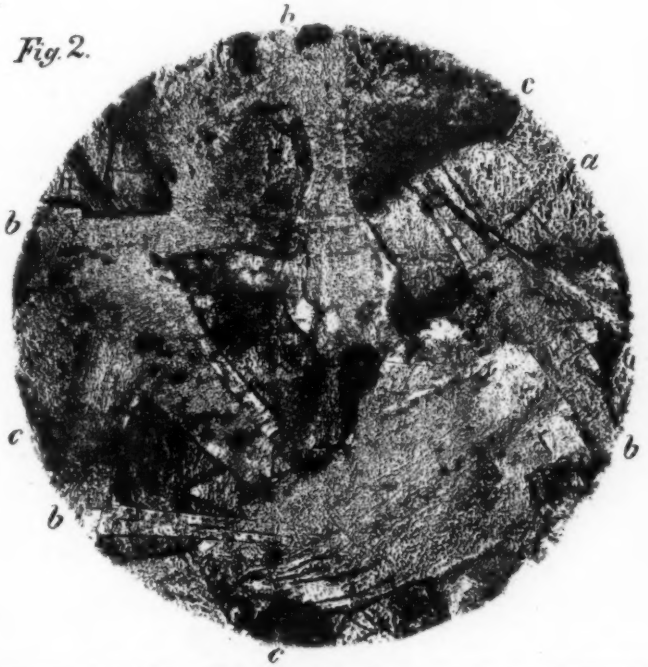

PHOTO-ZINCOGRAPH, by F. A. WENDEROTH & Co., 1328 Chestnut Street, Philada.

Pl. III.

Fig. 1.

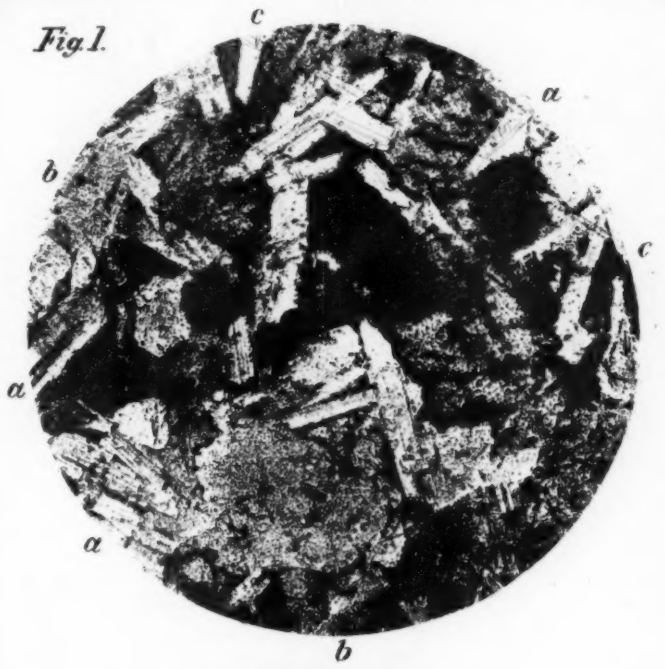

Fig. 2.

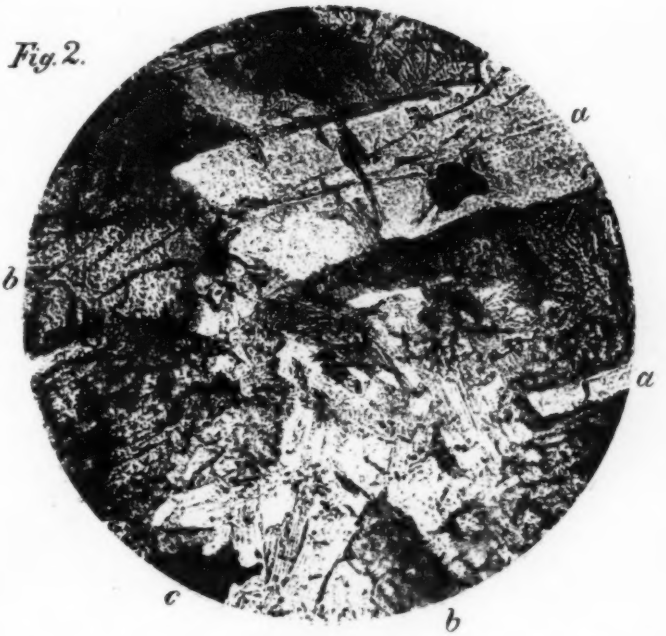

PHOTO-ZINCOGRAPH, by F. A. WENDEROTH & CO., 1826 Chestnut Street, Philada.

Pl. IV.

Fig. 1.

Fig. 2.

Fig. 3.

Fig. 4.

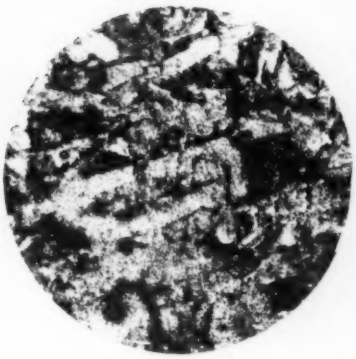

Fig. 5.

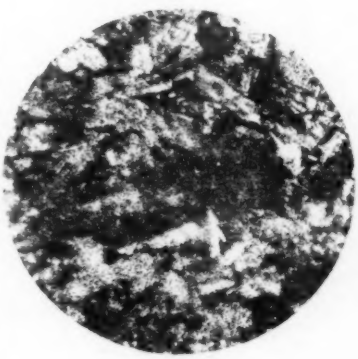

Fig. 6.

PHOTO-ZINCOGRAPH, by F. A. WENDEROTH & CO. 1328 Chestnut Street, Phila'a.

London Nature; and Society of Antiquaries; State Board of Health, Mass.; American Journal S. and A., New Haven; American Journal of Pharmacy; Medical News and Library; Penn Monthly; Board of Com. of Pub. Charities, Harrisburg; and Mr. J. E. Nourse, Washington.

Mr. Whitman reported progress for the Committee charged with estimating the cost of publishing Dr. Allen's paper.

On motion, the committee was continued.

Prof. Chase read a note on Cosmical Evolution.

Mr. W. E. Dubois communicated through the Secretary the results of an extended examination recently made in and for the Assay Department of the Mint at Philadelphia, of the practicability of assaying metals used in coinage by the spectrum apparatus. The paper was read and the drawings of the apparatus and spectra exhibited, and on motion, it was referred to the Secretaries, with power to publish the same with proper illustrations.

Mr. J W. Harden exhibited a model of a part of Big Sewell Mountain, Fayette Co., West Virginia, showing the number and position of the coal beds and limestones beds on the lands of the Langdale Coal and Iron Co., on the Kanawha River and Chesapeake and Ohio R. R. In the absence of Mr. Harden on account of illness, the Secretary explained the model and associated maps and sections, giving a description of the general geology of the lower coal measures in Virginia.

Pending nominations Nos. 753, 754, 755, 756 were read.

And the meeting was adjourned.

Stated Meeting, June 19th, 1874.

Present, 9 members.

Dr. Ruschenberger, in the chair.

Photographs for the Album were received, of Mr. F. Rogers, and of Senator Sumner.

A letter was received announcing the removal of the Société des Sciences Naturelles from Strasbourg to Nancy.

A letter was received from M. T. Leorgre, informing the Society of his election to succeed M. Quetelet, as Secretary of the Royal Belgian Academy.

Letters of acknowledgment were received from the N. H. S. at Zurich, (87), Aug. 20, 1873; the Royal Society at Edinburgh, (89), Dec., 1873; the Victoria Institute, London, June 5, (Proc. 13 Vols. and 1 part); and Smithsonian Institution. (XV, i.)

Letters of envoy were received from the Central Physical Observatory at St. Petersburg, April, 1874; Natural History Society, Zurich, Aug. 20, 1873; Victoria Institute, London, June 5, 1874; Department of State, U. S., Washington, May 23, 1874; and Coast Survey Office, Washington, May, 1874.

Donations for the Library were received from Mr. B. S. Lyman, Chief Geologist of Japan; Royal Prussian Academy, and Horticultural Society at Berlin; Natural History Society, Zurich; Société des Sciences, Nancy (Strasbourg); Flora Batava at Leyden; Royal Academy, Brussels; M. L. G. DeKoninck; Holland Society of Sciences, Harlem; Geographical Society, Anthropological Society, and Revue Politique, at Paris; Royal Observatory, and Royal Academy of Science, at Turin; Royal Institution, Royal Geographical Society, Royal Astronomical Society, and London Nature; Mr. Alex. J. Ellis, F.R.S.; Royal Society, Edinburgh; Essex Institute, Salem; American Academy of Arts and Sciences, and Natural History Society, Boston; Museum of Comparative Zoology, Cambridge; Anderson School of Natural History, Penekese; Rhode Island Society for the Encouragement of Domestic Industry, Providence; American Journal of Science and Arts, Prof. Jas. Hall, Academy of Natural Sciences, Historical Society, Franklin Institute, Journal of Pharmacy, Penn Monthly, American Chemist, Medical News and Library, Woman's Medical College, Water Department, Mr. E. D. Cope, Mr. H. C. Carey, and Mr. Isaac Lea, Philadelphia; Mr. T. J. Bingham, Harrisburg; Com-

mission for attending to Observations on the Transit of Venus; Engineer and War Departments, Washington.

The Committee to which was referred the cost of publishing the illustrations to Dr. Allen's Memoir, reported that it would cost $400. On motion an appropriation of $400 was ordered for that purpose.

Prof. Chase communicated two brief notes entitled—

1. On Rainfall in cyclonic years of Jupiter, at Greenwich, Philadelphia, Lisbon, San Francisco and Barbadoes.

2. On the Lunar Cyclical Rainfall at Barbadoes, for 27 years.

Pending nominations Nos. 753, 754, 755, 756 were read, and the Society was adjourned.

Stated Meeting, July 17th, 1874.

Present, 8 members.

Vice-President, FREDERICK FRALEY, in the Chair.

A letter from Dr. DaCosta, requesting the completion of his set of the Proceedings was read, and referred to the Committee on Publication, with power to take order.

Donations for the Library were received from the Royal Society of Tasmania; the Imperial Russian Academy, the Central Physical Observatory, the Natural History Society, at Riga; the Imperial Academy, Geological Institute, and Zoologico-Botanical Society, at Vienna; the Imperial Academy, German Geological Society, and Physical Society, at Berlin; the Societies at Bremen, Frankfort and Offenbach, the Hague, Lausanne and Bordeaux; the Musée Teyler: the Royal Academy, at Bruxell; the Academy of Medicine, Ecole des Mines, National Society of Antiquaries, and Revue Politique, at Paris; Mr. H. S. Munroe, of Yeddo; the Geographical Society of Mexico; the Royal Astronomical Society, Meteorological Committee, and Nature, in London; the Victoria Institute; the Philosophical and Literary So-

ciety, at Leeds; Boston Society of Natural History; Yale College, Peabody Museum, Silliman's Journal; the New Jersey Historical Society; the Penn Monthly, American Chemist, Journal of Pharmacy, and Franklin Institute, in Philadelphia; Peabody Institute, in Baltimore; War Department, Washington, and the Buffalo Society of Natural Sciences.

The death of Dr. Gouverneur Emerson, July 2, aged 78 was announced by Dr. Ruschenberger.

Dr. Genth read a communication in answer to criticisms by Dr. Hunt upon his paper upon Corundum, published in the Proceedings of the Society.

Dr. Charles M. Cresson communicated the results of an examination of an exploded locomotive boiler, with detailed accounts of experiments in reference to the causes of explosion.

Prof. Fraser communicated a note on certain formulæ of minerals, with reference to the question whether separate chemical compounds can co-exist in the same crystallized mineral.

Pending nominations, Nos. 753, 754, 755, 756, 757, 758 were read, and Nos. 753, 754 and 756 balloted for, and the following named persons were declared by the presiding officer duly elected members of the Society, viz.:

Sir Wm. George Armstrong, of Newcastle-on-Tyne.

Mr. Franklin Platt, of Philadelphia.

Mr. Henry Woodward, F.G.S., of London.

And the meeting was adjourned.

Stated Meeting, August 21st, 1874.

Present, 3 members.

Vice-President, MR. FRALEY, in the chair.

Dr. Genth presented a paper for publication in the Proceedings, entitled:—"Contributions from the Laboratory of

the University of Pennsylvania, No. 2. On an improvement of the Burette Valve." By Geo. A. König, Ph.D.

Dr. Genth communicated a paper entitled:—"Contributions from the Laboratory of the University of Pennsylvania, No. 3. On American Tellurium and Bismuth Minerals. By F. A. Genth."

And the meeting was adjourned.

Stated Meeting, September 18th, 1874.

Present, 8 members.

Vice-President, MR. FRALEY, in the chair.

A letter accepting membership was received from Mr. J. Norman Lockyer, dated 5 Alexandra Road Fenchly Road, London, June 25, 1874.

A letter accepting membership was received from Mr. Franklin Platt, dated 139 South Fifth street, Philadelphia, Sept. 8, 1874.

Letters acknowledging donations and exchanges were received from R. Academy, Lisbon, Aug. 3, 1774, (XII, ii, iii, XIII, ii, 67, 73, 74, 75, Catalogue II); the Society at Riga, Oct. 31, 1873, (XIV, iii, Proc. XII, 1, 2); the Imp. Academy at Vienna, Dec. 1, 1873, (88, 89); the Zoologico-Botanical Society, at Vienna, Jan., 1874, (Proc. XII, up to 89); the Royal Pontifical Academy d. N. L., at Rome, Dec. 9, 1873, (88, 89); the British Association, London, June 12, 1874, (XVI, 90, 91); the Royal Observatory, at Greenwich, July 21, 1874, (90, 91); the Royal Society, London, June 25, 1874, (III; XIV, ii, XV, i, 62, 88, 89, 90, 91); the Meteorological Office of the R. S., London, June, 10, 1874, (90, 91); the Zoological Society, London, July 3, 1874, (XV, i, 89, 90, 91); the Society of Antiquaries, Somerset House, London, June 25, 1874, (XV, i, 90, 91); the Statistical Society, 12 St. James Square, London, June 17, 1784, (XV, i, 90, 91); the Ratcliffe Observatory, Oxford, June 19, 1874, (XV, i, 90, 91); the Literary and Philosophical Society, R.

Inst., Liverpool, Dec. 31, 1873, (O.S. I to VI, N. S., I to XIII); the Literary and Philosophical, Leeds, June 8, 1874, (XV, i, 88, 91).

Letters of envoy were received from the Physical Society, Berlin, April 15, 1874; the Imperial Academy, Vienna, Feb. 23, 1874; the Zoologico-Botanical Society, Vienna, Jan. 7, 1874; Royal Hungarian Academy, Pesth, Nov. 10, 1873; Holland Society, Harlem, Dec., 1873; Society of Emulation, Abbeville, June 1, 1874; Teyler Museum, Meteorological Office, London, June 23, 1874; Literary and Philosophical Soc. Manchester, June, 1874; Literary and Philosophical Soc. Liverpool, Dec. 29, 1873; National Academy, B. Aires, May, 10, 1874; Museum, B Aires, April 20, 1874; Metropolitan Museum of Arts, New York, Sept. 16, 1874.

A letter was received from Mr. Alex. Agassiz, respecting his father's European Publications, to be distributed, dated July 22, 1874.

A letter was received from Mr. Geo Travers, dated Newstadt, A. H., July 4, 1874, offering for sale the Shai-n-Sinsin papyrus, price £120 sterling.

Donations for the Library were reported from the R. and Imp. Academies at Berlin and Brussels; the Societies at Riga, Görlitz, Leeds, Glasgow, and Salem, Mass; the Observatories at Prague, San Fernando, and Oxford; the Geological Bureau, at Stockholm; the City of Pesth; the S. d N. L, at Rome; the Geographical Society, American Society for the encouragement of National Industry, Museum of Natural History, School of Mines, Weekly Gazette of Medicine, Revue Politique, and Chev. Leopold Hugo, of Paris; the Royal, Chemical, Asiatic, Astronomical, Zoological, and Antiquarian Societies, Victoria Institute, Cobden Club, Meteorological Committee, and Nature, of London; the Geological Museum, at Montreal; the American Antiquarian Society; Silliman's Journal; Dr. Jarvis of Dorchester; Prof. Roehrig, of Ithaca; the Naturaliste Canadien, of Quebec; the American Chemist, New York; the Metropolitan Museum, of New York; the Franklin Institute, Penn

Monthly, and Dr. R. J. Levis, of Philadelphia; Prof. S. S. Haldeman, and the University of Missouri.

The death of Dr. Jeffries Wyman, of Cambridge, Sept. 4, aged 60, was announced by Dr. LeConte.

Mr. Eli K. Price, as Chairman of Committee on Nursery, &c., communicated "A list of Oaks imported by the Fairmount Park Commission, in 1874, for the Michaux Grove, being the selection of John C. Cresson, Esq., when last in Europe, showing which of them are living."

Mr. Lesley described an upthrow fault recently discovered by Mr. Chance, volunteer assistant of the Second Geological Survey of Pennsylvania, crossing the Schuylkill river in the gap of the Kittatinny Mountain, below Port Clinton.

Pending nominations, Nos. 755, 757, 758, and new nominations, 759, 760, 761, 762, 763, were read.

And the meeting was adjourned.

Stated Meeting, October 2d, 1874.

Present, 11 members.

Secretary, Dr. LeConte, in the Chair.

Photographs for the Album were received from Mr. Thos. Meehan, and Prof. Stephen Alexander.

A letter from the Rantoul Literary Society, dated Rantoul, Champaign County, Ill., Sept. 28th, 1874, requesting the publications of the Society, was read, and on motion, the Society was ordered to be placed on the list to receive the Proceedings.

A letter from the Ohio State Librarian, dated Columbus, O. Sept. 22, 1874, requesting a copy of the Catalogue of the Library was read, and on motion, the request was granted.

A letter from Dr. Fredk. Krauss, on behalf of the Verein für Vaterländ. Naturkunde in Würtemberg, dated Stuttgart, Aug. 10, 1874, asking for the completion of their set of Proc. A. P. S., and a complete set of Transactions A. P. S., and promising to complete the set of V. f. V. N. in W.

Jahrgänge (30 years in 3 parts) for the A. P. S., Library, was read, and on motion, the request was granted.

Letters of acknowledgement were received from the R. Academy, Copenhagen, (XV, i, 90, 91); K. K. C. Anstalt für Meteorologie und Erdmagnetismus, Vienna, (90); Prof. Hochstetter, (89); Dr. Jos. Hyrtl, (88, 89); Linnean Society, London, (XIV, ii, XV, i, 88 +); New York Historical Society, (92).

Letters of envoy were received from the Linnean Society, and N. Y. State Library.

Donations for the Library were received from the Editor's of Revue Politique, Paris; Nature, Royal Society, and Linnean Society, London; Prof. Silliman and Dana, N. Haven, N. Y. State Library, Regents of the University, Buffalo Society of Nat. Sciences, Penn. R. R., U. S. Naval Observatory, and National Educational Association.

The death of M. Elie de Beaumont, at Paris, Sept. 24, 1874, aged 75, was announced by Dr. Genth.

Mr. Delmar, late director of the U. S. Bureau of Statistics, read a communication on the resources, productions, and social condition of Egypt.

Pending nominations, 755, 757 to 763, were read.

And the meeting was adjourned.

Stated Meeting, October 16th, 1874.

Present, 12 members.

Vice-President, Mr. Fraley, in the chair.

A letter accepting membership was received from Mr. Henry Woodward, F.R.S., dated British Museum, London, Oct. 3. 1874.

A letter was read from Mr. Jared P. Kirtland, dated East Rockport P. O., Cayahoga County, Ohio, Oct. 1, 1874.

Letters from B. Westermann & Co. and E. Steiger, Booksellers, and on motion made, it was resolved to instruct the Secretaries not to sell single numbers of the Proceedings,

lest the stock of Proceedings be so diminished as to make it impossible to supply corresponding Societies.

The request of the Leeds Philosophical and Literary Society for Nos, 75 and 79, to complete their set, was on motion, granted.

Letters of acknowledgment were received from the Society at Riga, Feb. 28, 1874, (90, 91); Boston Public Library, Oct. 12, 1874, (XIV, 92); and War Department, Washington, Oct. 5, 1874, (92).

Letters of envoy were received from the Swedish Geological Bureau, Stockholm, Nov. 15, 1873; and the Prussian Academy, Dec., 1873.

Donations for the Library were received from the Academies at Berlin and Brussels, and Salem, Mass.; the Society at Zwickau; the Paris Geographical Society, and Revue Politique; London Nature; Boston Natural History Society; Journal of Medical Sciences, Journal of Pharmacy, Medical News and Library, Mr. H. C. Carey, and the Hon. B. H. Brewster, of Philadelphia.

Mr. Lesley described the marked change in the aspect of the northern and northwestern counties in the State during the last thirty years, and the progress of the Geological Survey of that region; the facilities afforded for it, and the private collections of fossils in it, at Mansfield, Warren and Titusville; the discovery of the Devonian (No. IX) fish-beds at various places from the Hudson to the Alleghany rivers; the differentiation of the Conglomerate from the oil region sand rocks, and of the Marshall group from the Chemung, &c.

Pending nominations, 755, 757 to 763, and new nomination No. 764, were read.

Nominations 755 to 763 were balloted for, and after scrutiny of the ballot boxes by the presiding officers, the following were declared duly elected members of the Society:

Rev. James Freeman Clarke, of Boston.

Franz Ritter von Hauer, of Vienna.

Rawson W. Rawson, Governor of Barbadoes.

Prof. S. P. Sadtler, of Philadelphia.
Prof. G. A. König, of Philadelphia.
Prof. C. F. Himes, of Carlisle.
Dr. R. S. Kenderdine, of Philadelphia.
Mr. A. R. C. Selwyn, of Montreal.
And the meeting was adjourned.

Stated Meeting, November 6th, 1874.

Present, 16 members.

Secretary, Dr. LeConte, in the chair.

Letters accepting membership were received from Prof. Samuel P. Sadtler, dated Philadelphia, Oct. 19; from Prof. George A. König, dated Philadelphia, Oct. 19; from the Rev. James Freeman Clarke, dated Jamaica Plains, near Boston, Mass., Oct. 20; and from Prof. Charles F. Himes, dated Carsisle, Pa., Nov. 4, 1874.

A letter was received from the relatives of M. F. P. G. Guizot, dated Val Richer, Sept. 13, announcing his death on the preceding day, Sept. 12, at the age of 86.

Letters of acknowledgment in receipt of Proceedings A. P. S., were read from the Observatory at Munich, Aug. 7, (Nos. 90, 91); Astronomical Society, at Leipsig, July 20, (90, 91); Royal Society, at Göttingen, July 6, (XV, i, 90, 91); Lyceum of Natural History, N. Y., Oct. 12, (92); and University of Toronto, Oct. 19, (84, 92. Wants 86 to 91.

Donations for the Library were announced from the Asiatic Society of Japan; the Swedish Statistical Bureau and Geological Survey; the Danish Archæological Society; the Academies at Berlin and Copenhagen; the German Geological Society; the Imperial Institute at Vienna; the Academy at Dijon; the Geographical and Anthropological Societies, and Revue Politique, at Paris; the Victoria Institute, Royal Geographical Society, and Nature, at London; the Geological Society of Glasgow; the Geological Survey of Canada; Essex Institute; Yale College; Silliman's Journal;

Franklin Institute; Penn Monthly; Gen. W. A. Stokes; Smithsonian Institution; Bureau of U. S. Engineers; Dr. Hayden; Mr. Outenbridge; the Medical News; and the Buffalo Society of Natural Sciences.

The death of Prof. Samuel J. Gummere, President of Haverford College, at Haverford, Oct. 22, aged 63, was announced, and Prof. Thos. Chase, was on motion, appointed to prepare an obituary notice of the deceased.

Mr. Britton exhibited to the members present large specimen pieces of coals sent for metallurgical analysis from the Luray Mine, Carbon Mine, and mines near Rocky Spring Station on the Union Pacific Railroad, 830 miles west of Omaha. The character, age, and relationships of these coals with the so-called Lignitic beds of Hayden, the Denver and Raton and Santa Fe coals, were discussed at length by Dr. Genth and Dr. LeConte.

Pending nomination, No. 764 was read, and the meeting was adjourned.

Stated Meeting, November 20th, 1874.

Present, 17 members.

Vice-President, Mr. Fraley, in the chair.

A Photograph for the Album was received from Prof. Traill Green, of Lafayette College, Easton, Pa.

A letter respecting the cataloguing of Libraries was received from Mr. W. C. Flagg, Secretary Ill. S. Farmer's Association, dated Moro, Ill., Nov. 10, 1874.

A blank to be filled was received from the Secretary of the Bureau of Education, at Washington, dated Nov. 11, 1874.

Letters acknowledging the receipt of the Society's Publications, were received from the Hungarian Academy of Sciences, Oct. 17, (XV, i, 88, 89, 90, 91); the R. Bavarian Academy, Sept. 15, (XV, i, 90, 91); the Philosophical and Literary Society, at Leeds, Oct. 28, (75 and 79); Prof. C. E. Anthon, New York, Nov. 18, (81 to 92); Prof. Traill Green,

Easton, Pa., Nov. 12, (81 to 92); Dr. Robert Peter, Lexington, Ky., Nov. 9, (81 to 92); and the Ohio State Library, Columbus, Nov. 13 (Cat. Pt. I).

Letters of envoy were received from the R. Bavarian Academy, Munich, Sept. 13, Mr. Stan. Meunier, Professor of Comparative Geology in Natural History Museum, at Paris, Oct. 28; the Meteorological Office of the Royal Society, in London; and the Smithsonian Institution.

Donations for the Library were received from the German Geological Society, the R. Prussian Academy, the Geological Association, at Dresden; the Vaudoise Society, at Lausanne, the Batavian Society Ex. Phil., at Rotterdam, the Revue Politique, M. Stan. Meunier, the R. Astronomical Society, London Nature, Boston Public Library, Academy of Natural Sciences, Franklin Institute, American Journal of Pharmacy, U. S. Coast Survey, Department of the Interior, and Mr. Adolph Schmidt, Jefferson City.

The volume on Comparative Geology presented by M. Meunier, was on motion, referred to a committee to be appointed at the next meeting.

The death of Mr. Charles B. Trego, Treasurer of the Society, at Philadelphia, Nov. 10, aged 80 years, was announced by the Vice-President, and on motion, Mr. S. W. Roberts was appointed to prepare an obituary notice of the deceased.

Mr. Britton exhibited and explained a model illustrating his method of keeping a laboratory free from the gases evolved when metals and minerals are dissolved in acids.

He dissolves in test tubes supported in position on wire gauze frames. The tops of the tubes are covered with glasses shaped like tubular funnels inverted, the tubular end of which being bent at nearly a right angle are made to pass horizontally into a long wooden chamber four inches wide by six inches deep. The chamber may be of any length; it connects at either end or in the centre with a wooden chimney, six by twelve inches in the clear, passing from the laboratory up and above the roof of the building. Heat is applied to the lower end of the tubes by moveable Bunsen burners. The gasses are carried away as fast as evolved by the constant current of air which passes through the chamber and up the chimney.

So completely have the gasses been conducted away, that several very delicate Becker balances have been in use for some years within a few feet of the tubes, without being perceptibly affected. He uses tubes va-

rying from one to two inches in diameter and about ten inches long—and also flasks. Any number may be used at the same time, set about six inches apart. He has frames for thirty-six. It is best to make the funnels pear-shaped, to allow their edges to slip into the tubes that any drops of condensed moisture may not fall outside.

Mr. Britton also exhibited several mounted burettes for volumetric analysis of the kind described in the Journal of the Franklin Institute, for May 1870, and which he has had in use for more than nine years. He exhibited them to show that the one exhibited by Dr. Geo. A. Koenig, at the meeting of the Society, held August 21st, 1874, differed in no essential feature from them.

Mr. Britton had tried wood, leather, lead, tin, glass, india-rubber and cork, for the stopper or valve. He preferred close-grained cork when using solutions of per manganate and bichromate of potash, and this after five thousand iron determinations with it. Glass he preferred to all other substances when using acids or strong alkaline solutions.

The graduation was on white paper behind the tube. The thumb knob of the screw was behind the frame, but the spring and valve was in front. This arrangement he preferred. The contents of the tube could be discharged much faster than necessary for analytical purposes, or so slow that only a fraction of a drop could be caught on the stirring rod and conveyed to the solution to be tested in the vessel beneath.

He also exhibited an adjustment of the spring and screw to the rod-stoppered burette. The burette was mounted on a stand. A spring lever was on the top and connected at one end with the rod-stopper, and at the other end with a metal rod. The latter extended down the back of the instrument to near the bottom, and had attached to it a thumb-screw arrangement. By simply turning the screw the stopper could be completely controlled while the eye watched the flow.

Mr. Britton referred again to the Rocky Mountain coals exhibited at the last meeting, simply saying in advance of analysis that they were all coking coals.

Mr. Poole obliged the members present with descriptions of the coals of Nova Scotia, and of the character of the gold quartz, veins, and present condition of the gold-mining industry of the province.

Dr. LeConte offered for publication in the Proceedings, a list of North American Iepidopteræ (platypterices, &c.,) with notes by Augustus R. Grote, of Albany.

Minutes of the last meeting of Officers and Members in Council, were read.

Pending nominations, No. 764, was read.

Mr. Fraley nominated in behalf of the Committee of Finance, Mr. J. Sergeant Price, to fill the vacancy left by the

death of the Treasurer. On motion, Mr. Price was elected to fill the vacancy.

Mr. Fraley reported that he had received and was prepared to turn over to the Treasurer elected, the quarterly interest on the Michaux Legacy, due Oct. 1. 1874.

And the meeting was adjourned.

Stated Meeting, December 4th, 1874.

Present, 17 members.

Vice-President, MR. FRALEY, in the chair.

A letter accepting membership was received from Baron Franz von Hauer, dated Nov. 7, 1874.

A letter requesting additional copies of Proceedings and Transactions, was received from the Holland Society of Science, at Harlem, Nov. 3, 1874.

Letters of envoy were received from the Entomological Society, of Belgium, and the State Department, at Washington.

A letter was received from the Baron de la Roncière le Noury, V. A. President of the Geological Society at Paris, with documents, asking for the concurrence of the A. P. S., in the International Congress of Geographical Sciences to be held next spring, in Paris.

Donations for the Library were received from the Editor of Flora Batava, Leyden; the Entomological Society, Belgium; Annales des Mines; Revue Politique; London Nature; Geological Society, and Society of Antiquaries, London; American Chemist; Prof. James Hall, and the Regents of the University of New York; Silliman's Journal, Franklin Institute, Penn Monthly, Mrs. Emma Seiler, of Philadelphia; and Dr. T. Sterry Hunt, of Boston.

The death of John Meredith Read, Ex-Chief Justice of the Supreme Court of Pennsylvania, at Philadelphia, Nov. 29, aged 77, was announced by Mr. E. K. Price, who, on motion, was appointed to prepare an obituary notice of the deceased.

Prof. G. Guyot, of Princeton, N. J., Prof. Cook, of New Brunswick, N. J., and Prof. Lesley, were appointed the committee to report on M. Meunier's book, received at the last meeting.

Mr. Britton reported analyses of Rocky Mountain coals, and exhibited the cokes obtained from them.

Dr. Cresson reported on their gas producing and heat producing qualities.

Mr. Goodfellow said that before the next meeting news would be received of a rare event, for which astromomers had been waiting and preparing for a century. Next Tuesday the Transit of Venus would again occur, the times of which as calculated for Washington he gave. So extensive and costly are the preparations for observing this event in distant parts of the world made by various Governments, that it becomes evident the time has arrived when public sentiment is alive to the value, and government action is ready to supply the needs of accurate science, for the benefit of society at large.

Mr. Goodfellow then gave a sketch of the history of the Observation of the Transit of 1769, and showed, from Dr. Smith's memoir in the Transactions of the American Philosophical Society, that Dr. Smith's calculations of the sun's parallax, while they widely differ from the results of Encke, approximated much nearer to the truth.

Dr. König explained again by diagrams, the essential points of difference between Mr. Britton's burette, the high value of which he acknowledged, and his own published improvement upon it. Mr. Brinton insisted that they were essentially the same. Mr. Fraley said that the decision of such a question must be left to the practice of Chemists.

Dr. W. I. Hoffman's letter to Dr J. L. LeConte on the practice of Cremation by the Pàh-Ute Indians, of Eastern California, was then read by the Secretary, and Dr. Horn confirmed Dr. Hoffman's statements, adding that the practice was common to all branches of the Pàh-Ute Tribe.

Mrs. Seiler's recently published investigations on the voice in speech were then described by the Secretary, and the

two capital points which the learned authoress considers to be new discoveries were pointed out, namely, the fixed pitch of the consonant, and the duplex instrumentation of the voice; the mouth and the "vocal organs" commonly so-called, being two entirely different and independent instruments acting in harmony, but the mouth being entirely capable of speech after the destruction of the larynx and cords.

Prof. Frazer described by diagrams the phenomenon of exfoliation in the syenite-like rocks of Gettysburg. A discussion ensued in which Dr. König expressed his dissent from Naumann's views respecting the cause of granitic exfoliation being the sun's heat. Dr. Genth also called attention to the fact that southern boulders were evidently not produced in the same way as northern boulders.

The report of the late Treasurer of the Society as made out by his administrator, was read by the Treasurer, Mr. Price, and regularly referred for examination to the Finance Committee.

Pending nomination, No. 764 was read.

On motion of Mr. E. K. Price. it was

Resolved, That the Treasurer be directed to pay one half the income received and to be received from the Michaux Legacy, to the Treasurer of the Fairmount Park Commissioners, for the Michaux Grove, &c, agreeably to arrangement of March 18, 1870.

The appointment of a Standing Committee of Botanists on the purchase of trees for the Michaux Grove, in Fairmount Park, was moved by Mr. Price, and laid over by the rules, to the next meeting.

The Curators, on motion, were authorized to permit Mr. Herbert Welsh to copy the portrait of Washington, in possession of the Society, under such regulations for its safety as the Curators may provide.

And the meeting was adjourned.

JUPITER-CYCLICAL RAINFALL.

By Pliny Earle Chase, Professor of Physics in Haverford College.

(*Read before the American Philosophical Society, June 19th*, 1874.)

The records of daily rainfall for twenty-seven years, at "Husband's" Station, Barbadoes, for which I am indebted to the courtesy of His Excellency Governor Rawson W. Rawson, C. B., have enabled me to extend my cyclical researches, and to discover some new and interesting features in the cosmical disturbances of local meteorology.

Although my previous investigations have convinced me that each of the planets exerts, on our atmospheric currents, an appreciable influence, which might be usefully formulated for any given station, provided the observations were enough extended, I have thought it best to confine myself mostly to the study of such weather modifications as are dependent upon Jupiter and the moon.

Those who are accustomed to think of simple tidal disturbances as the only ones to which we can reasonably look for planetary influence, and even those who are also willing to attach some importance to the modification of atmospheric elasticity by direct attraction, are doubtless prepared to believe, on sufficient evidence, that the moon may affect our winds and storms to a slight degree, while they are extremely skeptical,

TABLE I.

Normal Percentages of Rainfall at Barbadoes in Jovian Synodic Years.

	1847–55.	1855–63.	1863–72.	1847–58.	1859–72.	1847–72.
1.	124	132	82	111	110	112
2.	110	151	88	107	125	116
3.	102	156	93	101	131	116
4.	98	151	89	94	131	112
5.	102	137	78	91	119	105
6.	107	124	79	99	102	100
7.	106	121	73	108	91	100
8.	95	122	87	110	91	101
9.	75	121	102	101	95	98
10.	62	120	109	94	92	96
11.	67	123	119	101	102	101
12.	77	117	132	107	109	108
13.	86	95	139	105	107	106
14.	99	75	139	102	104	103
15.	100	70	137	101	104	103
16.	99	69	129	99	100	99
17.	92	65	124	94	94	94
18.	83	64	123	88	92	90
19.	74	69	114	81	90	86
20.	68	75	100	74	87	81
21.	68	77	90	72	84	78
22.	82	76	84	80	81	80
23.	109	82	84	97	87	92
24.	135	90	89	113	98	106
25.	141	84	97	116	100	108
26.	126	76	99	105	98	102
27.	114	82	94	96	99	98
28.	122	85	82	102	96	99
29.	142	88	78	120	87	103
30.	142	104	76	126	91	108

or altogether incredulous as to any traceable influence exerted by either of the primary planets.

But if we admit the possibility of ethereal rotation, or tendency to rotation, and especially if we consider how much we have yet to learn concerning the properties of elastic fluids we may reasonably look for important disturbances from the cumulative effects of the undulations which are exerted by planetary action. Those disturbances, however, may be so modified by the daily fluctuations of the lunar tides, by differences in the stratification of the atmospheric currents, and by abnormal local influences of various kinds, as to obscure, either wholly or in part, all traces of cyclical regularity in their alternations of maxima and minima.

In the accompanying comparative tables there are both accordances and discordances, for which I can account in no other way than by the hypothesis of cumulative aerial waves, excited by the combined action of the two constituent orbs of our binary star, Sun and Jupiter. The magnitude of the flexures in the several rain-curves seems too great, the resemblances and gradations in order of magnitude too marked, the approximations to consistent regularity too uniform to be merely accidental. The deviations, however, from seemingly normal curvature are

TABLE II.

Normal Percentages of Rainfall at various Stations in Jovian Synodic years.

	Greenwich, 1815–69.	Philad'a, 1820–74.	Lisbon, 1854–70.	S. Francisco, 1849–72.	"Husband's" 1847–72.	Average.
1.	100	105	81	118	112	103
2.	102	102	88	136	116	109
3.	100	99	99	132	116	109
4.	98	100	108	111	112	106
5.	99	101	110	99	105	103
6.	102	101	99	96	100	100
7.	104	98	86	85	100	95
8.	102	96	84	71	101	91
9.	97	95	96	76	98	92
10.	91	95	107	108	96	99
11.	90	99	112	141	101	109
12.	94	106	113	141	108	112
13.	97	113	115	118	106	110
14.	95	115	120	107	103	108
15.	92	110	122	104	103	106
16.	90	103	117	87	99	99
17.	92	98	103	67	94	91
18.	97	100	86	63	90	87
19.	100	103	76	69	86	87
20.	104	104	76	73	81	88
21.	109	101	81	79	78	90
22.	114	96	88	84	80	92
23.	115	91	96	87	92	95
24.	111	88	103	90	106	100
25.	105	88	108	98	108	101
26.	103	90	113	114	102	104
27.	102	94	116	129	98	108
28.	100	99	112	119	99	106
29.	97	103	98	98	103	100
30.	97	106	84	98	108	99

so great and so frequent, that my convictions of causal nexus are often wavering. I cannot expect that others, who have been less interested in the study of cyclical meteorology, will accept my qualified belief in systematic disturbances by Jupiter or other planets, until a sufficient number of observations have been compared at a sufficient number of stations, to furnish data for successful prediction.

Notwithstanding my persuasion that such data will be at some time attainable, I see, as yet, few encouraging indications of any conclusive and satisfactory termination for my researches in this particular direction. This very vagueness and lack of certainty furnishes a new and somewhat unexpected argument in favor of appreciable lunar weather-action ; for, if the tabulation of rainfall in planetary cycles had not shown so great deviations from uniformity, the regularity might, perhaps, have been regarded as an accidental resultant from some unknown law of harmonic functions, entirely independent of the influence assumed as a supposed cause. The impossibility of explaining the regularity by simple tidal action would have fully justified such skepticism.

But when we find that the lunar tabulations bring out such accordances as I have already shown (Proc. Amer. Phil. Soc., x, 436—9, 523—37 ; xi, 203 ; xii, 38—9, 178—90, 523—9, 556—9), while the Jovian influence, although possibly greater in point of magnitude, is more questionable and more easily overcome or hidden, I think we have good reason to consider the fact of lunar influence as practically demonstrated, and to hope, at no distant day, for a valuable extension of our weather-forecasts by means of that influence.

Comparing the several sets of normals in these tables, by noting the agreements or disagreements in the excess or deficiency of average rainfall at corresponding periods, we find no marked evidence of resemblance in the nine-years' groupings ; but in the twelve-year groups, corresponding nearly to a Jovian year, there are eighteen agreements to twelve disagreements, and there is a degree of resemblance in the aspect of the plotted curves which it is difficult to believe accidental. A similar comparison shows a similarity of character between the curves at Philadelphia, Lisbon, San Francisco and Barbadoes, and an opposition between each of them and the higher-latitude curve of Greenwich.

CYCLICAL RAINFALL AT BARBADOES.

By Pliny Earle Chase.

(*Read before the American Philosophical Society, June 19th*, 1874.)

I confess to a feeling of some disappointment at the first results of my examination of the lunar monthly rainfall at "Husband's" Station in the island of Barbadoes. If I had no more satisfactory evidence of cyclical regularity, and if further study had not enabled me to eliminate some of

the disturbing elements, I should have been compelled to consider the evidences of lunar influence on the weather quite as questionable as those of discoverable planetary influence.

My predictions of increasing range and regularity of disturbance, in approaching the equator, had been confirmed by comparisons of observations in Great Britain, Canada, New England, Philadelphia, Lisbon and San Francisco. Their apparent failure in an island which seemed, on many accounts, so favorably situated for their verification, cast a shadow of doubt on my previous conclusions, and I was even inclined to ask if it could be possible that the many coincidences which I had taken as indicative of law, were merely accidental.

This skepticism, however, was soon removed. The cumulative action of the aerial tidal-waves in blending different currents, of which I have so often spoken, may be easily obscured, if it is not wholly overborne, by insular influences, by the violent hurricanes to which the Windward Islands are subject, and even by the occasional intrusion of the south-easterly trade-winds. Where there is a liability to sudden heavy rains, any one of which would suffice to make important changes in a curve

TABLE I.

Normal Percentages of Rainfall at "Husband's," in Thirtieths of a Solar Year, and on Lunar Days at Different Epochs.

	Solar.				Lunar.						
	1847-'56.	1856-'64.	1865-'73.	1847-'73.	S. Sol.	W. Sol.	Ver. Fq.	Aut. Eq	V. and A. Equinox.	S. and W. Solstice.	Year.
1	64	62	82	69	92	82	122	95	101	73	93
2	55	51	75	60	98	83	104	100	104	83	96
3	50	49	62	53	100	90	94	110	116	92	103
4	45	54	52	50	99	95	94	113	119	95	104
5	38	53	41	44	98	98	103	107	114	96	104
6	33	41	29	34	100	105	110	104	109	103	104
7	34	30	23	29	107	118	105	109	104	111	109
8	34	33	23	30	115	130	94	123	106	114	116
9	37	44	25	35	119	135	88	133	113	117	121
10	48	50	31	43	117	136	89	136	124	122	125
11	65	53	45	55	115	135	95	126	121	131	123
12	82	63	60	69	117	127	104	111	107	133	116
13	92	82	76	84	115	109	104	101	101	126	108
14	94	95	101	96	115	90	98	98	104	121	105
15	98	96	130	107	118	78	90	93	99	121	100
16	107	101	140	115	108	75	82	82	83	111	90
17	118	115	129	120	88	79	80	70	70	97	79
18	132	132	122	129	79	89	86	66	67	96	77
19	140	144	139	141	82	101	88	74	72	102	84
20	137	146	163	148	83	106	86	85	82	96	89
21	141	145	170	152	78	97	81	91	92	86	88
22	154	147	165	155	77	83	77	89	93	80	85
23	160	154	166	160	83	80	83	84	83	78	82
24	164	174	183	173	92	89	97	86	76	79	86
25	181	197	190	189	97	100	107	93	81	82	93
26	196	204	167	190	100	104	103	102	94	92	99
27	181	182	131	166	105	101	105	107	110	105	106
28	140	136	106	128	108	100	130	109	120	102	110
29	103	94	92	96	101	97	154	106	122	84	107
30	79	74	85	79	92	89	147	99	112	71	98

representing the mean of several years' observations, it is not strange that great care should be needful in order to determine the approximate character of the normal flexures.

My previous discussions having shown that the lunar rain-curves at a given station vary somewhat at different seasons of the year, I first computed the normal curves at "Husband's" for each month of the year independently, and then "smoothed" the curves by taking the fourth successive means between the daily normals of successive months. This second series of normals, although insufficient for any conclusive inferences based on comparisons between consecutive months, should furnish approximate evidence of the normal changes, as well as means for making eighteen entirely independent comparisons between curves with intervals of five or six months. The normals for these two series of curves are given in Tables III. and IV. If there were no other than an accidental connection between the several curves, the chances of agreement or disagreement between the normal excesses or deficiencies of rainfall, in each independent comparison, would be equal, there being a probability of 15 days agreement and 15 days disagreement. The actual accordances and discordances and the ratios indicative of a *vera causa* in lunar action, are given below, 1 being the ratio of probable accidental agreement.

TABLE II.

Normal Proportions of Rainfall at "Husband's" on Lunar Days of each Calendar Month, for Independent Comparisons.

	Jan.	Feb.	Mar.	Apl.	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.
1.....	29	31	10	49	66	51	49	121	121	112	76	41
2.....	32	32	11	30	60	58	54	132	136	120	67	50
3.....	34	31	17	15	58	64	60	129	143	157	73	58
4.....	33	29	25	9	58	76	64	110	144	164	95	48
5.....	34	34	30	11	57	85	73	91	137	148	112	33
6.....	38	41	27	16	56	78	94	83	120	148	119	31
7.....	42	39	18	19	58	68	107	99	108	154	134	42
8.....	47	31	12	18	60	70	102	126	114	161	156	48
9.....	56	26	9	15	62	77	95	138	130	170	166	45
10.....	61	29	10	16	59	88	93	125	151	181	162	43
11.....	58	38	13	21	49	114	89	107	154	158	153	44
12.....	49	42	21	29	41	134	85	104	123	134	142	43
13.....	38	36	28	30	39	119	89	113	96	135	114	47
14.....	32	27	34	23	41	85	106	127	93	148	77	59
15.....	30	22	32	16	45	64	124	134	93	143	53	64
16.....	31	24	22	15	44	57	119	115	83	117	56	53
17.....	34	27	14	16	45	55	94	81	71	98	69	42
18.....	40	28	15	18	49	63	72	62	61	99	77	47
19.....	44	28	15	23	48	75	63	73	64	105	91	55
20.....	41	31	12	30	36	75	62	84	79	114	111	46
21.....	35	31	11	35	26	68	69	80	93	126	114	29
22.....	33	28	12	38	22	61	73	85	90	129	100	20
23.....	36	29	10	36	31	55	71	102	72	121	88	20
24	41	31	12	24	57	54	67	109	65	117	97	23
25.....	38	31	17	12	77	57	66	103	85	119	117	31
26.....	34	32	21	12	68	67	74	103	105	133	120	40
27.....	33	35	20	32	46	77	85	120	106	156	102	49
28.....	32	39	19	58	50	69	81	136	98	170	92	55
29.....	28	39	10	68	71	52	63	127	96	165	91	53
30.....	27	35	14	63	76	45	50	115	104	142	88	44

		A.	D.	Ratio.
Jan.	June.....	24	6	4.00
"	July	25	5	5.00
"	Aug.....	20	10	2.00
Sum.....		69	21	3.29
Feb.	July	24	6	4.00
"	Aug.....	23	7	3.29
"	Sep.	24	6	4.00
Sum.....		71	19	3.74
Mar.	Aug.....	18	12	1.50
"	Sep.	21	9	2.33
"	Oct.	20	10	2.00
Sum.....		59	31	1.90
Apl.	Sep.	20	10	2.00
"	Oct.	17	13	1.31
"	Nov.	19	11	1.73
Sum.....		56	34	1.65
May	Oct.	24	6	4.00
"	Nov.	25	5	5.00
"	Dec.	23	7	3.29
Sum.....		72	18	4.00
June	Nov.	23	7	3.29
"	Dec.	23	7	3.29
"	Jan.	24	6	4.00
Sum.....		70	20	3.50

		A.	D.	Ratio.
July	Dec.	23	7	3.29
"	Jan.	25	5	5.00
"	Feb.	24	6	4.00
Sum.....		72	18	4.00
Aug.	Jan.	20	10	2.00
"	Feb.....	23	7	3.29
"	Mar.	18	12	1.50
Sum.....		61	29	2.10
Sep.	Feb.	24	6	4.00
"	Mar.	21	9	2.33
"	Apl.	20	10	2.00
Sum.....		65	25	2.60
Oct.	Mar.	20	10	2.00
"	Apl.	17	13	1.31
"	May	24	6	4.00
Sum.....		61	29	2.10
Nov.	Apl.	19	11	1.73
"	May	25	5	5.00
"	June.....	23	7	3.29
Sum.....		67	23	2.83
Dec.	May	23	7	3.29
"	June.....	23	7	3.29
"	July	24	6	4.00
Sum.....		70	20	3.50

	A.	D.	Ratio.
Summer, Winter.....	22	8	2.75
Spring, Autumn.....	21	9	2.33
Vernal Equinox, Autumnal Equinox.....	18	12	1.50
Summer Solstice, Winter Solstice.....	23	7	3.29
Mean Annual.....	22	8	2.75

TABLE III.

Normal Percentages of Rainfall at "Husband's," on Lunar Days of each Calendar Month, for Independent Comparisons.

	Jan.	Feb.	Mar.	Apl.	May	June	July	Aug.	Sep.	Oct.	Nov.	Dec.
1.....	76	98	57	184	128	70	62	112	116	81	74	95
2.....	83	99	64	112	115	81	68	122	130	87	64	116
3.....	89	97	95	56	112	89	75	119	137	114	70	133
4.....	88	91	138	35	112	105	80	102	137	119	93	111
5.....	90	106	169	41	111	118	92	84	131	107	108	75
6.....	99	129	153	60	109	109	117	77	115	107	114	72
7.....	109	122	103	70	112	94	134	92	104	112	129	98
8.....	124	97	67	67	115	97	128	117	109	117	150	111
9.....	147	81	54	58	119	107	119	128	124	123	160	104
10.....	161	91	54	59	114	122	117	116	144	131	156	99
11.....	153	120	75	80	94	158	112	100	147	114	148	101
12.....	129	133	116	108	79	186	106	96	118	97	137	100
13.....	101	113	162	113	75	165	111	105	92	98	110	109
14.....	84	83	194	87	78	118	133	118	89	107	74	136
15.....	79	69	183	61	86	89	155	124	88	104	51	148
16.....	80	75	123	56	86	79	160	107	80	85	54	123
17.....	88	85	82	61	86	77	118	75	68	71	67	97
18.....	105	87	87	67	94	88	90	58	59	72	74	109
19.....	116	89	83	87	89	104	79	68	61	76	88	127
20.....	108	98	70	114	70	105	78	78	75	82	107	105
21.....	93	99	64	131	51	94	87	75	89	91	110	66
22.....	86	88	65	141	42	85	92	79	86	93	96	47
23.....	96	90	58	134	61	77	88	93	69	88	85	46
24.....	109	99	65	92	110	74	83	101	62	85	94	53
25.....	101	98	96	44	149	79	83	95	81	86	113	71
26.....	89	109	117	46	130	93	92	95	101	96	116	92
27.....	88	111	115	122	89	107	107	112	101	113	98	112
28.....	84	122	109	218	96	96	102	126	94	123	88	126
29.....	75	122	105	257	138	73	79	118	92	120	88	121
30.....	71	109	76	237	147	63	68	107	99	103	86	102

If these accordances can be properly interpreted as indicative of lunar influence, they represent results analogous to those we might look for from the simple means of observation extended over a period of about one hundred years. When the average daily temperature is most settled, near the Summer and Winter Solstices, the lunar curves seem most accordant, while they are most opposed when the changes of season and temperature are most rapid and in the most opposite directions, near the Vernal and Autumnal Equinoxes.

Having thus shown that the general agreement is too great to be regarded as merely accidental, and that there are valid reasons for important differences in the curves for different months, we are prepared for the sixty-six comparisons of entirely independent curves, for which Table III. furnishes the data. The sums of the agreements and disagreements between the curves for each month and for all the remaining months, are as follows:

	A.	D.		A.	D.		A.	D.
January,	173	157	May,	170	160	September,	198	132
February,	200	130	June,	198	132	October,	202	128
March,	190	140	July,	196	134	November,	188	142
April,	148	182	August,	180	150	December,	179	151

Here again we find convincing evidence, and in some respects more satisfactory than before, of a uniformity of lunar action that is obscured by the preponderating variations of solar action, only in the single month

TABLE IV.

Normal Percentages of Rainfall at "Husband's," on Lunar Days of each Calendar Month, for Independent Comparisons at Intervals of Five or Six Months.

	Jan.	Feb.	Mar.	Apl.	May	June	July	Aug.	Sep.	Oct.	Nov.	Dec.
1.....	84	90	111	126	102	86	86	98	99	90	81	81
2.....	91	91	94	102	97	89	95	109	108	94	83	85
3.....	99	95	87	89	93	92	98	113	117	110	98	96
4.....	97	96	91	91	97	97	98	109	118	115	106	100
5.....	94	104	105	99	104	104	99	101	109	111	104	96
6.....	101	114	113	101	104	107	102	99	103	108	106	100
7.....	111	110	102	97	102	108	109	105	106	112	116	115
8.....	118	101	86	91	102	111	116	116	116	122	129	130
9.....	122	98	79	89	105	113	119	124	126	132	136	136
10.....	127	107	83	90	109	117	120	125	132	138	138	136
11.....	130	120	99	98	117	125	120	118	124	128	129	131
12.....	123	125	116	110	125	132	120	108	106	111	116	120
13.....	109	116	119	112	118	125	118	105	104	100	103	107
14.....	99	105	111	102	102	114	120	113	102	97	94	97
15.....	94	95	98	91	93	110	123	117	102	90	85	88
16.....	87	86	84	88	87	103	115	106	91	80	75	81
17.....	86	85	79	77	83	90	90	81	73	70	72	79
18.....	97	94	85	84	88	86	77	67	65	69	77	88
19.....	108	100	89	90	94	90	80	70	69	76	87	101
20.....	104	99	93	89	89	88	83	79	80	87	95	103
21.....	89	91	92	85	81	83	83	83	87	93	109	93
22.....	77	83	90	83	76	80	84	85	87	90	88	81
23.....	79	86	90	86	79	80	85	85	82	82	80	77
24.....	88	92	91	94	91	87	86	85	81	82	83	84
25.....	94	93	91	99	102	94	88	87	88	91	95	96
26.....	97	95	94	97	102	99	96	96	98	102	104	102
27.....	101	105	110	106	102	104	107	108	107	107	105	103
28.....	104	114	136	135	113	104	108	111	119	119	105	103
29.....	99	112	151	159	124	96	93	102	106	106	103	101
30.....	89	99	134	151	119	87	83	94	100	98	93	90

of April. If we examine still more closely for clues which may be of possible future service in the study of the reasons for accordance and discordance, we find that in nineteen instances the discordance is greater than we should expect if it were merely casual; in five, it is the same; and in forty-two it is less; as will be seen by the following statement of the numbers of discordances, and the curves by which they are severally shown:

EXCESS OF DISCORDANCE.

20, Aug.—Nov.; 19, Jan.—Mar.; Apl.—May, Apl.—Oct., May—Jul., May—Dec., Nov.—Dec.; 18, Jan.—Apl., Apl.—Jul., Apl.—Sep.; 17, Jan.—Aug., Jan.—Oct., Apl.—Aug., Apl.—Nov., May—Jun.; 16, Feb.—Aug., Mar.—May, Apl.—Jun., Sep.—Dec.

AVERAGE DISCORDANCE.

15, Jan.—Feb., Jan.—May, Feb.—Dec., Mar.—Apl., Jun.—Aug.

EXCESS OF AGREEMENT.

14, Jan.—Sep., Feb.—May, Mar.—Aug., Mar.—Nov., Apl.—Dec., Oct.—Nov.; 13, Jan.—Dec., Mar.—Sep., Mar.—Dec., Aug.—Sep.; 12, Jan.—Jul., May—Aug., May—Nov., Jun.—Dec., Jul.—Sep., Jul.—Dec.; 11, Feb.—Apl., Feb.—Jun., Feb.—Jul., Feb.—Sep., Mar.—Jun, Jun.—Oct., Jul.—Aug., Jul.—Nov., Oct.—Dec.; 10, Jan.—Jun., Feb.—Oct., Feb.—Nov., Mar.—Oct., May—Oct., Jun.—Jul., Jun.—Sep.; 9, Mar.—Jul.,

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TABLE V.

Normal Percentages of Rainfall at "Husband's," on Lunar Days of each Calendar Month, for Forecasts.

	Jan.	Feb.	Mar.	Apl.	May	June	July	Aug.	Sep.	Oct.	Nov.	Dec.
1.....	85	94	110	117	106	91	89	95	97	90	81	82
2.....	90	92	95	99	96	92	97	105	105	95	86	86
3.....	97	94	90	89	92	94	100	110	114	109	101	97
4.....	98	95	92	92	95	92	100	109	115	114	107	101
5.....	97	102	103	102	103	103	101	103	108	109	104	98
6.....	104	108	108	105	104	105	102	101	103	106	105	102
7.....	112	108	103	99	102	107	108	106	107	112	115	114
8.....	117	102	91	92	101	110	115	116	118	122	128	127
9.....	120	99	86	90	103	113	119	123	127	132	135	132
10.....	124	106	91	93	106	116	120	126	132	136	138	134
11.....	128	118	104	103	114	122	121	120	124	127	129	130
12.....	123	122	117	118	123	127	120	111	108	111	116	120
13.....	110	115	116	115	118	122	116	108	103	102	103	107
14.....	100	105	107	104	105	113	117	112	104	98	96	97
15.....	93	96	91	93	97	109	118	115	103	92	87	89
16.....	85	86	84	83	90	102	109	104	92	82	78	81
17.....	84	84	80	79	83	90	88	81	74	71	73	79
18.....	94	92	87	85	86	84	77	69	66	70	78	88
19	104	99	92	90	91	88	80	72	69	75	88	99
20.....	103	99	94	90	89	87	83	80	82	87	95	101
21.....	91	91	90	86	82	83	83	84	88	96	101	96
22.....	79	83	87	85	79	80	83	85	87	89	87	82
23.....	80	85	88	85	81	81	84	84	83	81	80	78
24.....	88	91	92	92	91	88	86	84	82	82	83	85
25.....	93	93	94	98	99	94	89	88	89	91	94	95
26.....	98	95	95	97	100	99	96	96	99	102	103	101
27.....	102	105	108	106	104	104	106	108	107	107	105	103
28.....	106	117	130	130	116	107	108	110	110	108	106	104
29.....	103	118	143	148	126	102	96	101	105	105	103	101
30.....	92	105	130	139	119	94	87	93	98	97	94	91

Jun.—Nov., Jul.—Oct., Sep.—Oct., Sep.—Nov.; 8, Aug.—Oct.; 7, Jan.—Nov., May—Sep., Aug.—Dec.; 6, Feb.—Mar.

The greatest amount of change produced by the lateral smoothing is shown in the following summary of comparisons between Table III. and Table V.:

	A.	D.		A.	D.		A.	D.		A.	D.
Jan.	22	8	Apl.	21	9	Jul.	26	4	Oct.	24	6
Feb.	26	4	May	19	11	Aug.	23	7	Nov.	23	7
Mar.	23	7	Jun.	22	8	Sep.	23	7	Dec.	18	12

Table V. is formed from Table IV. by taking two additional successive means. I am inclined to think that its normals would best represent the means of observations extending over indefinite long periods, but Table III. would perhaps more nearly indicate the disturbances of mean lunar influence that might be expected at different seasons of the year. It is possible that by systematically comparing monthly observations with each of the tables, probable causes for any marked deviations from the normals might be found.

Table I. presents three sets of solar and six sets of lunar normals, each of which is derived from observations extending over equal, but non-correspondent, periods of one hundred and eight months. They therefore furnish data for three entirely independent solar, as well as for seven entirely, and three nearly independent lunar comparisons. The lunar columns cover twenty-seven years' observations in the following months: Summer Solstice, May to August, inclusive; Winter Solstice, November to February, inclusive; Vernal Equinox, February to May, inclusive; Autumnal Equinox, August to November, inclusive; Vernal and Autumnal Equinox, March, April, September, October; Summer and Winter Solstice, June, July, December, January. The solar columns exhibit, as we might expect, the closest accordance. The lunar, in spite of the great irregularities in Spring and Fall, also exhibit a predominance of accordances in each of the ten comparisons, whereas, if there were no well-marked lunar action, we ought to have found a predominance of disagreements in five of the comparisons.

The accompanying curves illustrate some of the more important results of the foregoing discussion:

Curves 1–12 (Lunar), illustrating Table IV.

1. January.	4. April.	7. July.	10. October.
2. February.	5. May.	8. August.	11. November.
3. March.	6. June.	9. September.	12. December.

Curves 13–15 (Lunar), illustrating Table I.

13. Summer Solstitial, continuous line.
    Winter " broken line.
14. Vernal Equinoctial, continuous line.
    Autumnal " broken line.
15. Mean Equinoctial, continuous line.
    " Solstitial, broken line.

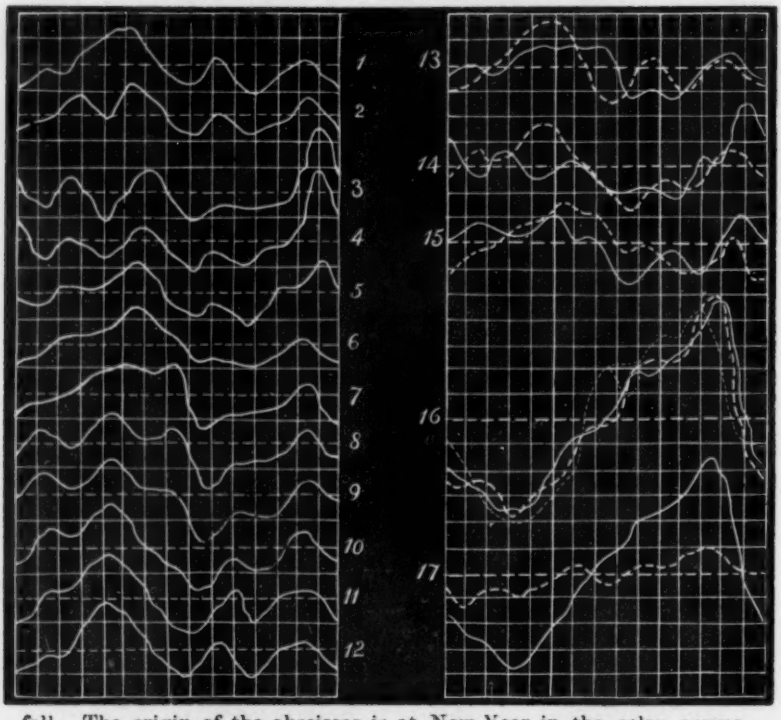
Curve 16 (Solar), illustrating Table I.

16. 1847–'55, continuous line.
1856–'64, broken line.
1865–'73, dotted line.

Curve 17 (Solar and Lunar), illustrating Table I.

17. Solar mean, continuous line.
Lunar " broken line.

The horizontal line in each figure represents the mean daily rainfall for the entire period represented by the curve; the abscissas, the times; and the ordinates, the normal percentage of excess or deficiency of rain-



fall. The origin of the abscissas is at New Year in the solar curves, and at full moon in each of the lunar curves, except figure 17, where it is taken at new moon in order to show the analogous effects of increasing radiation, both in the solar and in the lunar curves. At Lisbon, where the prevailing winds are from an opposite quarter, the lunar influence is also opposite, increasing lunar radiations and decreasing solar radiations, each bringing increase of rain.

"Husband's" Station is in St. Lucy's parish, northwestern part of Barbadoes, not far from the coast, 184 feet above the sea. In the following tables, new moon, first quarter, full moon, last quarter, are respectively marked by, n, a, f, b.

RAINFALL AT "HUSBAND'S," BARBADOES.

January 1st, to December 31st, 1847.

Days.	Jan.	Feb.	Mar	Apl.	May	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.	Total
1	f	.23	f	.06			.05	.02 b	.48 b	.03	.25	.06	
2	.30			.10	.01		.01	.50	.04		2.90		
3	.10			.07			.01 b	.23	1.28		.70	.15	
4	.07	.01	.01			.01		.16	.23				
5	.05		.07	.11		b .06	b 1.67						
6	.07						.01	.10	.13	.04	.27		
7	.01		.07		b		.02	1.15	.31	.71 n		n .02	
8	.03 b			b			.36				.04	.01	
9	b .01		b .07			.07	.03		n .64 n		.03	.01	
10	.06		.05	.34		.63	.03 n	.09	1.55	.73	.01		
11	.23	.01		.26			.01	.01		.17	.05	.01	
12	.16	.05	.01			n .11 n	.51			.09		.14	
13	.14		.02	.12								.12	
14	.19	.15	.05	.16 n	.48	.01		.25	1.34	.40	.99 a	.01	
15	.05 n	.06		n .03	.08		.04	.09		.09 a	.79	.63	
16	n	.01 n				.10		.05	1.89	.09	.03	.24	
17	.28	.01	.10			.08		.10 a	.04 a		.04		
18		.06	.10	.11		.03	a	.05	.56		.04	.45	
19	.02	.09			.01			.05	.36			.01	
20	.25	.02	.01	.27		a	a	.02	.27	.28			
21	.23 a	.02		.06 a			.05		.03			f	
22	.06	.02	.01 a	.10		.04	.04		1.27	.03 f	.53	.03	
23			a				.20	.10	.50 f	.01	.26		
24	a .13							.02 f	.22	.11	.11		
25	.02							.01	.16	.25	.07		
26	.04		.47				.36 f			.72		.33	
27	.04					f		.16	.05	.70	.03	.24	
28	.01	.01				t		1.80	.57	.66			
29			.13		f .04	.42		.02	.45	.43 b	.61 b	.03	
30	.02		.01 f	.06	.06	.08	.05	.01		b .94	.50	.01	
31	f .05		f					.01		.30		.22	
Sum	2.62	0.75	1.00	1.85	0.68	1.58	3.45	5.00	12.37	6.78	8.25	2 72	

January 1st, to December 31st, 1848.

Days.	Jan.	Feb.	Mar	Apl.	May	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.	Total
1	.35					n					.40		
2	1.34						.11		.13	1.12		.48	
3	.01			n	n		.13		.20	3.75		a	
4	.03 n					.04	.89			1.54 a			
5	.05		n					.37 a		a			
6	n .28					.27		a			1.50		
7	.03		.10		.18	.10	.32	2.95					
8	.02			.13		a	a	1.62	3.30				
9	.08	.01			a			1.52					
10		.05		a		.09		.19			f	f	
11		a .02	a .05										.49
12	.05	.09	.06							f			
13	a				.43				f.23				
14	.03						.15 f		1.73				.31
15	.01			.09		.25		.13		1.78			
16	.15	.07			f		f .86	.03					
17	.36	.48	.31		1 04			.13			b	b	
18	.08 f		.01 f		f					.36			.19
19	.45	.01 f	.04			1.25	.36		b	b			
20	f .05	.10			.37				1.50	1.50			.35
21	.15							b 1.75			.59		
22			.09	.07			.45						
23	.03		.16				b		.03	1.80	.13		
24	.08				b	.21		.10					.50
25	.05	.08		.30	b	.35			.35		n	n	.23
26		.01		b				.31		n 1.15			
27		b .03	b				1.16		n				.65
28	b	.09			1.07			n		.20	.60		.37
29		.08					1.10			.78			
30				.31		n .05	n				.05		
31			.14		.94		.17	.13		2.25		.21	
Sum	3.68	1.12	0.96	0.90	4.03	2 55	5.70	9.20	7.50	16.23	3.27	3.78	

RAINFALL AT "HUSBAND'S," BARBADOES.

January 1st, to December 31st, 1849.

Days.	Jan.	Feb.	Mar.	Apl.	May.	Jun.	July	Aug.	Sept.	Oct.	Nov.	Dec.	Total
1		.20	a			.05		.07		.78			
2	a					1.20			f .17	f		.72	
3						.19		f.40				.07	
4	.13								.70	.85		.03	
5						f	f .12					.01	
6					1.20					.30		b .26	
7		f		f	f	.14	.10	1.50	.07	1.75	b	.54	
8	f .35		f. 12		.49				b .42			.81	
9						.30		.23	b.50	.90		.01	
10	.04	.30				.38	.39		.75	.30		.05	
11	.20			.74	.11		b		.14	.05			
12							.54	.45		.02			
13						b	b .26					.01	
14	.32	b			.11		.87				n .04	n .04	
15				b	b	.37	.36		.78		.87		
16	b	.97	b.84		.42	.67	.11	.84 n		n			
17						1.00			.33	.05	.05		
18							.14 n		.24	.32			
19				.42			n			1.20			
20	.33					n .15					.25		
21		.60											
22		n	1.04 n		n			1.40			a .02	a	
23			2.12				.87				.03		
24	n		n				.18		a	a			
25	.52				.05	.05		a .08	.12	.55		.36	
26	.87	.14		.44	.22	1.35 a							
27						a .95	.14					.02	
28		.04			a		.58					.04	
29	.57			a					.85	.05 f	.14 f	.01	
30					.36	.14	.58		.60			.05	
31	a .67		a				.56			f			
Sum	4.00	2.25	4.12	1.60	2 96	6.94	5.80	4.97	5.25	7.54	1.40	3.03	

January 1st, to December 31st, 1850.

Days.	Jan.	Feb.	Mar	Apl.	May	June.	July	Aug.	Sep.	Oct.	Nov.	Dec.	Total
1		2-08	.06	.08		.15		b .02	.09			2.70	
2		.11		.02		b .05	b	.20	.27			2.10	
3	.49	b				.51	.25			.11	n	n .03	
4	.04			b .03	b	.28	.27	.22	.02	3.06	.13	.23	
5	b		b	.08				.15		n .26	.16		
6				.02	.16		07	.95 n				.25	
7	.02	.40		.02	.42			n .15	.09	.02		.05	
8	.01						2.75		.02	4.35	.05		
9						.15	n .28	.05	.18			.07	
10						n .45	1.13	.28	.14			.11	
11		.10			n .14			.28			a .55	a .11	
12		n		n			.10		.03	a .02	.17		
13	n .25		n .06					.02	a .07		.02		
14				.30		2.90	.48	a .10	.17	.18			
15				.16			.65	.22	.23	.44		.09	
16			.44	.06		a.45	a .04	.84	.08	.16		.07	
17		.04					.49	.61		.10	.82		
18				.05	a		.22				.02	f	
19	.16	a	a	3.00	.10		.18			.41	f	.08	
20		a		.08		.06				f	.08	.12	
21	a	.30				.30		.12	f	.15	.08	.02	
22		.08						f .01			.50		
23					1.67		.06				1.74		
24		.25				f	f .03	.02	.06	.13	.04		
25				.08	f	1.25	.11		.25		.02	b	.10
26		f14	f	.38			.36			.13	b .06		
27	f		f .24				.09	.73	.19	b	.54	.15	
28						.80	.35	.82	b .33	.05	3 82		
29							.02	.11	.04	3.00	1.50		
30					.05	.30		b 2.40	.10	3.20	.67	.07	
31	.15				.16		.35	.97		.15		.04	
Sum	1.12	3.50	.80	4.36	2.72	7.80	8.28	9 28	2.36	15.92	10.97	6.39	

RAINFALL AT "HUSBAND'S," BARBADOES.

January 1st, to December 31st, 1851.

Days.	Jan.	Feb	Mar	Apl.	May	June.	July.	Aug.	Sep.	Oct.	Nov.	Dec.	Total
1		n .05		n	n				.18 a				
2	n	.03 n						a		1.05	2.02	.41	
3	.08				.73			a	.15	.10	.11	.24	
4	.04	31	.03								.02		
5			.04				a	.50	.04	.22	.31		
6	07					a	.65		.54			f .32	
7			.03	.24	•		.31		.04	.13	.08	.03	
8		.03	.04	a				.15			f		
9	.04 a			a			.09				.03	.80	
10	a .12		a		.39	.22	.07		f	f .02	.18	.11	
11						.19	.04	f2.69					
12		.50	.13	.90		.36			08		.03		
13	.12	.18	.57		f	f		.94	2.78	.48	.90		
14				.25	.07	.26	.18		.77	1.46	.83		
15	.07 f	.12	.24 f		f		.03			3.74		b .11	
16	.03	.25	.04		.82	.73	.44				b .10	.39	
17	f .03	.36 f				1.25		.67		b		.27	
18		.09			.11	.18	.51		b			.09	
19	.04					.32	.09 b	.04		1.21		.19	
20						.05	.04	.64		.24		.11	
21					b	.23 b		.24	.58		.14		
22		b .42		b	b	.22	.15	.04	1.67	.25 n		n .28	
23		.04		.20		.20	.40	.30			.11		
24	b .07		b		.22	.04		1.88		n.57	.05		
25	.10	.03		.03			.31	.08 n	.26		.20		
26						.15	.18 n	.05		.36		15	
27	.03			.02	1.02	.70			1.10		.40	25	
28						.91 n	.17	.12	.15	.15		.16	
29	.05			.08		n	.42					.02	
30					n .09		.64	.08	.04		a .05 a	.09	
31	.16							.50		a			
Sum	1.05	2.36	1.12	1.72	3.45	6.01	4.72	8.80	8.38	9.98	5.56	4 02	

January 1st, to December 31st, 1852.

Days.	Jan.	Feb.	Mar	Apl.	May	June.	July.	Aug.	Sep.	Oct.	Nov.	Dec.	Total
1		.03				.45	f .04				.04	.09	
2					.01 f						.01	.07	
3			.05		f	.12	.18				.15	1.10	
4		.35	.16 f		.11	.03	.36	.04			b .35 b		
5		f .22				.04	.22		.32		2.05	.21	
6			f .13			.07	.04	.11 b	.22 b		.37	.01	
7	f		.14			.05	.10 b	.27	1.65		1.15	.05	
8	.30	.12	.02			.03	.10		.51	1.21	3.78	.05	
9	.12	.03			b	.18 b		.68	.02	2.74	.60	.06	
10		.32	.08		b					.13		n	
11	.30	.04		b		.09	.01	1.40		.03 n		.05	
12		b	b .48		.13		.04	3.30	1.20			.20	
13	b .27	.18	.36	.01	.03		.16	.02	n .04 n		1.76	1 04	
14	.10		.16	.06	.14	.23			.01	.34		1.30	
15				.01				n .09	.01				
16	.24					.14 n	.26	.07			4.05		
17	.05			.02		n .03		.07				.21	
18	.06	.02	.25		n .05		.04	.01			a .52 a		
19	.02	n .20		n			.27	.08		a		.06	
20	.07		n					.02 a			2.86		
21	n .12				.14	.02							
22		.08			.66	.06	.14 a		.41				
23	.35	.01			.12	.31 a	.02	.20	.32				
24	.12	.09				a		.15	.09				
25	.19				.25	.04	.01	.03				.05	
26		.03	.19	.27	a .08	.10	21				f	f	
27	.07			a	1.70	.02	.01			f		.26	
28		a .01 a			3.22	.76	.14		f				
29	a .07	.15						f .09	.26	1.31		.35	
30	.10			.10		.01	.03	1.09	.07	4.37		.03	
31							t					.05	
Sum	2.55	1.88	2.02	1.37	6 64	2.78	2.38	7.81	6.03	10.13	18.29	5.24	

RAINFALL AT "HUSBAND'S," BARBADOES.

January 1st, to December 31st, 1863.

Days.	Jan.	Feb.	Mar	Apl.	May.	June.	July.	Aug.	Sep.	Oct.	Nov.	Dec.	Total
1		b .27		.31			.20	.06	.03	.82 n	.20	.05	
2	b .08	.16 b				1.14	.02	.11	.04 n	.01	.22	.15	
3	.29	.85	.18			.69		1.64 n		.82	.20	.55	
4		.03						n .10			.05		
5	.23		.12	.16			.10	.15	.02	.08	.82	.01	
6			.12			n	n .57			.10	.02		
7	.14		.04		n .23	.02			.26	.01 a	1.09 a		
8		n	.26 n	.04	.45	.19	.14	.06	.01		.20		
9	n	.14 n	.04	.09	2.23	.05	.12	.19	.13 a	.02	1.83		
10		.85	.39	.06	2.28		.12	.03 a		.73	.31		
11			.32	.10			.85 a	.19	.12				
12	.26	.60	.25	.26				.08	.02	.05	.01		
13	.20		.01		.21		a .09	.37	.85				
14			.08			a .04			.05	.07	.04		
15		a .01	.18	.05		.08	.05			.01 f		f	
16				a	a		.05			f	.48		
17	a	.02 a	.03	.01		.11	.18		f .65	.68	.20	4.50	
18			.08	.02		a .60		f .03	2.37	.24	.05	.11	
19			.17	.04			.21	.11	.13		.10		
20			.08	.14		.03 f		1.20		.08	.01		
21				.29	f	.03		1.16		.80			
22	.05		.03		f 3.77	.07		.14	.05	.46	.18		
23	.02 f		.06 f	.34		1.20	.11	.10	.07	b	.36 b		
24			.05	.13	.03				.48	.15	.01		
25	f	f .01	01				.02	b	.05 b	.35	.09		
26	.06	.02		.04		.11	.09 b	.20	.02	.85	.45	.64	
27	.06			.03		.09 b	.85	.40	3.23		.33		
28	.12	.02	.12	.25	.11 b		.22		3.61		.01		
29	.28			.09	b		.28	.02	.01	1.42		.15	
30				b		1.10	.02	.02	.06		n .01	n .01	
31	.09		b		4.28		.03	.39					
Sum	2.48	2.97	2.62	2.46	13.59	5.55	4.26	6.75	12.26	7.75	7.27	6.17	

January 1st, to December 31st, 1864.

Days.	Jan.	Feb.	Mar	Apl.	May.	June.	July.	Aug.	Sep.	Oct.	Nov.	Dec.	Total
1			.01	.23		.57		a .04	.60	.45	2.27		
2		.15		.05		.03	.40	.14				.20	
3			.15	.11		a .40 a	.63	.02		.24		1.21	
4		a .01	.02	.08			.29			.23 f		f .25	
5	a .03	.04		a .13 a		.03		1.59	.04	.95	.67	.15	
6			a .01	.01			.05	f	.03 f		.28	.07	
7				.04			.62	.02	14	.30	.16		
8						1.35	f		.02	.09			
9		.11					.05		.58		1.64		
10	.16		.06			f .06 f		.06	.65		2 50		
11			.32			.40	.08		.01		3.25		
12	.28 f			t		.15	.19			.77 b	2.90 b		
13			.01 f			.01	.15		.02	b1 07	.65		
14	f .40	f	05	.01				.01 b		.30	.07		
15	.29	.11	.01	.25	.17		.28 b	.22	.19			.87	
16			.02		1.14	.02 b	.05	.01	.01	.09			
17		.01			.02 b	.20	.01		.23	.11		.12	
18		.05	.08			.06	.02			.44			
19			.07 b	b						1 84		n	
20		b	.01		.08				.02	n	.20	.24	
21	b		b				1.63	.11	.11 n	.07	.17		
22						.27	.05		n .09				
23	.19	.14				.15	.39 n	.09	.07				
24							n 1 95		.18			.04	
25		.15				n	.04		.18	.17		.06	
26	.11 n			n	.13	.20		.19		1.21 a		a	
27	.16	.04		n .07		.68		.68	.44				
28	n .21	.03 n				.86	.44	.15	.01 a				
29						.05	.07	.40 a	.04	.21			
30			.30				.90	.23	.01				
31	.02		.04					a .16					
Sum	1.85	.84	1.12	1.02	1.55	5.49	8 29	4 12	3.67	8.54	14 76	3.21	

RAINFALL AT "HUSBAND'S," BARBADOES.

January 1st, to December 31st, 1855.

Days.	Jan.	Feb.	Mar	Apl.	May	June.	July.	Aug.	Sep.	Oct	Nov.	Dec.	Total
1	.25 f		.16		f .70	.15		1 20	.22	.60 b	.09 b	.60	
2	.30			f	1.66			1 01	b	.48	.33		
3	f	.24 f			.85			.02 b	.05				
4	.04	.09						b .51	.15				
5	.71						.31	.08	.32		.24	.64	
6	.46	.15					b .04	.03	1.21		.30	.64	
7			.19			b .10	.11	.13			1.22	.06	
8			.79		b	.81		.10	1 05				
9	.57 b		.06 b					.38		n	n		
10	11	.05 b			.20		.90	06	.35 n				
11	b1 76					.65	3.00	1.64 n	.73				
12	.12				.14		.45 n	.33				.86	
13	.11	.08	.31			n		.05			.28		
14	.39				.28 n		.15	.03		.50	.03	.09	
15				.14 n			.04		.31	.26	.10		
16		n		n		.30	.20	.03	.60	a	.15 a		
17			n			.09	.08		2.10	.10			
18	n	.20		.02			.20	.22	.05 a				
19							.40	.24 a					
20							.30 a	.03	.05			.86	
21	.39			.18		.35		.23					
22		.08	.05	.20		a .60 a				.05	.04	.10	
23		a .18	.06		a. 09	.90				.60 f	.81 f	.05	
24	a	.28		a .14	.38	.20	.10	3 20	.55		.05		
25			a			.25	.44	2.84 f		f .13	.10		
26			.50			.15				.73	.81		
27				.05		.30		f .73		.69	.25	.05	
28				.10		.63		.06	.01	1 06		.04	
29				.90	.20 f	.21 f	.10	.01		.10	.31		
30				2.20	.64	.05	.50	.15	.50		.26	.08	
31					f .14		.10			.10		b .18	
Sum	5.21	1 35	2.12	3 93	5 18	5.74	7 42	13.31	8.34	5.40	5 37	4 25	

January 1st, to December 31st, 1856.

Days.	Jan.	Feb.	Mar	Apl.	May	June.	July	Aug	Sept.	Oct.	Nov.	Dec.	Total
1	.31			.12		.11	50		.11		.02		
2		.05		.18		n	n .11				.18		
3		.02		.27			.56		1.08		.53		
4	.17		.32		n	.31	.07				.15	.12	
5	.20 n	.40	.44 n			4 20		.10			a .25 a	.16	
6		.30 n		.18				.08			2.34		
7	n .25	.10		.02		.02	.12	.70 a		a	.03	.73	
8	.08	.18	.04				a	1.30		.08		.75	
9		.03				.07	1.05	.88	.73	.04			
10						a .02 a	.10	.17	.18			.27	
11		.07			a		.28		.13		2.23 f		
12	.25	.10	.35 a		.20			.58		.03 f	.02		
13		a .40 a						.77	.72 f		.29	.34	
14	a .10	.02							f .25	.25	.02		
15	.05							.05				.05	
16	.05	.12					f			.22			
17	.02						f .10		.22	.09		.01	
18						f	.28			.32	.35		
19		.25			f					b	b		
20		f		f	.09	.01	.18		b	.07	.13	.05	
21			f	.01	34		.05	.04 b			.02	.45	
22	f				.39			b .07	.80		.36		
23				.01	.41		.20	2.55	25	.06	.03		
24						b	.01	.33	.27				
25					b	.03	.32	.45		.96			
26		.02		.50		.03	.05			.02		.02	
27			b	b	.22		.40	.10			n	n .05	
28		b			.41	.14			.06 n		.07		
29	b		b				.65		n	.02		.04	
30								n		.74	1.12	1.01	
31					.35		n			.14		.36	
Sum	1 48	2.06	1.15	1.29	2.42	4.94	5.03	8 17	4.80	3.04	8.14	4.41	

RAINFALL AT "HUSBAND'S," BARBADOES.

January 1st, to December 31st, 1857.

Days.	Jan.	Feb.	Mar	Apl.	May	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.	Total
1	.09 a			a		.09		.14	1.80		f .55	f .10	
2	-	.07	a		2.75			.28			.93		
3	a .02	.03			.05	.05	.30		f .06	f .07	.01		
4			.26	.16	.08	.17	.68	.24	1.00	.28			
5			.05		.38	.10		f .58	.41				
6		.37	.29	3.80	3.35			4.60	.28				
7		.12		.02		f .12	f .07		.04				
8		f .03	.09	.46	f			.12	.22		b	b	
9		.19		f	.20	.03		.20	.67		1.00	.31	
10	f	.88	f			.42		.30	b	b	.06	.03	
11		.10		.06		1.42	.06	.70	.68			.16	
12		.80	.68			.17	.90	b .25			1.35		
13		.01	.07			.28		.18		.01	.28	.10	
14			.38			.52	b			.01	1.29	.07	
15	.15		.26		.21	b .06			.02	1 21	.18	.25	
16	b .20	.20	.11		b		.11	.85	.82	.08	n	n	
17	b .10			b		.10	1.08		1.42	n .08	.95	.01	
18	.10		b				.05	.05	n .16	.48			
19	.04	.72					.41	n		.07	.06		
20	.06	1 51					1.42				.09		
21	.11	.03		.10		n	n .47		.40	.19			
22	.14	.22				.10		.31	.20		1 06		
23	.70	.17	.33		n .31	.06	.22	.13	.58	.40			
24		n .34		n		.45		.51	.07		a	a	
25	n		n			.66		.03	.10 a			.05	
26	.11				.10	.85		.02 a	.30		.50		
27		.02				.23	a	.75				.07	
28					a	a .16		.56		.17		.20	
29					.05	.21	.52	.06	.18	1.78		.50	
30	.10			a .27	a		1.20	.17	.20	.08	1 86	.08	
31	.12							1 14		.08		f .22	
Sum	1.84	5.51	2.52	4.87	7.48	6.09	7.65	11.67	9.01	4.99	10.17	2.15	

January 1st, to December 31st, 1858.

Days.	Jan.	Feb.	Mar	Apl.	May	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.	Tota
1									.54		1.21		
2	.15	.14					.20		.10	.04	1.00	.01	
3	.03	.40			.79		.18				.18		
4		.69				b	b	b	.40	.13			
5	.10	b .10			.02		.65			.04	n	n	
6	.15	.04		b .08	b	.31	.20	.05		1.57	.58		
7	b .25		b .08			.05		.14	n	n .70	.40	.78	
8	.10			.10	.07	.34	.35			.30		.07	
9							.30	n .31		.40		.84	
10	.01					.09	n		.01	.35	.12		
11	.02	.01			.02	n .23	.22	.13	.36	.42	.03	.02	
12			.10	.10	.05	1.01	.23	.16		.10	.11	.06	
13	.08	n		n	n	.10	.30	47	1.00	.16	a	a .16	
14			.30	.30	.03		.33	.07	.25	1.30	.01	.08	
15	n		n				.15	.25	a	a .51		.28	
16	.21				.05		.10	a			.10		
17						.09	a				.19	.11	
18	.09	1.60	.02	.02		a	.08		.02		.10	.36	
19					a .14			.04			.07	.05	
20		a		a	.06	.15	.28				.19	f .52	
21	.02				.13		.03	.00		f			
22	a		a .25	.25					f				
23							.20	f .10					
24							.08	f .04	.46			.10	
25					.05	f		.17	.18				
26	.05					f .22			.79		.30		
27	.02	f			f .02				.16	.77	b 1.30	b .12	
28				f	.23			.17	.21	.52			
29	f		f		.11	.03	.55			b 1.00		.65	
30							.40	.40 b	.12	.04		.13	
31					.17			b		.72		.01	
Sum	1.28	2.89	.75	.85	1 94	2.62	4.02	3 30	4.70	9.07	5.80	4 05	

RAINFALL AT "HUSBAND'S," BARBADOES.

January 1st, to December 31st, 1859.

Days.	Jan.	Feb.	Mar	Apl.	May	June.	July.	Aug.	Sep.	Oct.	Nov.	Dec.	Total
1	.04	.02					.03		.06	.80	.04 a		
2	.03	.25			n	.06		.65			a .60		
3	n	.03		n	.03		.02	.07		a	.48		
4	n .04	.10 n				.06		.43 a	.67	.10	1.54	.07	
5	.03	.01					a		.01		1 40	.44	
6	.07		.03			.15				.64		.21	
7	.02	.05			a	.15 a	.23			.20		.97	
8		.01					.15	2.19		.06	.14		
9		.27		a		.12	.05		.50	12	.02		
10	a			a .07						.31 f		f	
11		.14		.16		2.00				f .08		.08	
12	a	.05 a					.31		f	.14			
13				.02			.08 f			.02	.22	.51	
14	.23	.01	.06				.28			.18	1 34	36	
15	.04			.11	.10 f	f				.40	.05	.08	.08
16		.05			f .01	.30		.06		.20	.04	.30 b	
17	f		.03 f			.45				.18	b	.09	
18	f .03	.07 f				.09	.24			.20	2 02	.06	
19	.03	.15	.07						b	b			
20	.06	.05			.23		.22			.05			
21	.05				.20	.12	.05 b	.26		.18	.08	.11	
22	.17		.31		.06	.53	.38						
23						b .36	b 1.35					.10	
24	.20 b				b	.20	.07			1.00	n	n	
25	b			b .30	.15	.33	.94			.18	.04	.07	
26			b	.01	.33	.15	.02		n	n	.54	.10	
27	.18				.53	.54		.24			.37	.04	.18
28	.09	.68		.03	.28	.04	.07 n			.03	.22	.08	
29					.06	01 n				1 00	.04	.10	.16
30					.65 n	.08					.01		.13
31					n .20		.08				.08		.41
Sum	1.31	1.94	0.50	3 70	2 83	6.31	4.57	3.90	4 86	7.02	6.22	2.73	

January 1st, to December 31st, 1860.

Days.	Jan.	Feb.	Mar	Apl.	May	June.	July.	Aug	Sep.	Oct.	Nov.	Dec.	Total
1	a .05	.18	.15						.09	.05	.06		
2		.17						1 05	5 95	.07	1.58		
3	.26	.05	.11			f	f .10		.01	.01	.19	.02	
4	.03	.21				.16	.04	.20	.23	.02		1.34	
5		.16		f	f			.39		1.96	.75 b		
6		.05		.14				43	02	.10 b			
7	.04 f	.04 f		.06		.19	.21	.72	.61 b	.06		.35	
8	f	.20			.09			3.42 b	.04	.04		.24	
9	.03					.05	.38 b	.02		.14	.05	.02	
10	.26									.77			
11	.25			.11	.27 b		b			.86	.24		
12	.26	.04		.09 b		.23		.12	.14		n		
13	b			b	.01	.09			.09	.20 n			
14	.03		b				.09		.04 n	.22			
15	b .07	.07	.01			.07	.13		n 1 32			.14	
16	.01					.04		n 85	.41	.41	.05	.08	
17	.15	.04		.07		.38	1.00	.10			4 35	.02	
18	.03		.04			.63 n		.06	.02	30		.03	
19		.12		.02		n .07	.17	.11	.25	.11	.50	.21	
20		.02			n	.02	.26	.57	.10	.10 a	.02 a	.08	
21	n 30			n			.08		a .02 a	.11	.05	.40	
22	n	.28 n						.20		1 67	.07	1.81	
23	.01	.01					.31 a	1.70	.05	.08	.04		
24							.45		.03	.57	.08		
25				.20		a	a .30		.34	.04			
26		.15					.10	.05	.15	.02	.07		
27		.08		.05 a			.08		.20	.02			
28		.10		a .13					.42	.08 f		f	
29		a .70		.11		1.05		.24	.45 f	.01			
30			a			.01	.29	.12 f	.12				
31	a				.37			f .63				.20	
Sum	1.48	2.97	0.31	0.98	0.74	2.99	3.99	10.98	11.70	8.02	8 10	4.94	

RAINFALL AT "HUSBAND'S," BARBADOES.

January 1st, to December 31st, 1861.

Days.	Jan.	Feb.	Mar	Apl.	May	June.	July.	Aug.	Sep.	Oct	Nov.	Dec.	Total
1	.15		.01	.46 b		.21	.08		.10			.11	
2	.01 b	.42		b .07		.04	2.54				n	n .03	
3	.06		b	.01	.20	1.14	.63						
4	b .16	.02	.09		.10	.12		.02 n		n			
5						1.37	.96	.14	.04	.20			
6				.70	.11	1 13	n	.17	.18		.50		
7			.22	1.35	.34	.05	.12	.91	.13		.37		
8			.04	.20	.29 n	.60 n		.05		.08	.60		
9	.07 n			.35 n	.03	.10	.42		.43	1 52 a		a	
10			n		.08	.14	.46			a .01			
11	n	.64 n			.16	.01	.85	.77 a	.05	.15			
12	.03	.36		.04	.03				.03	.04			
13	.28			.16	.10		.46 a	.02	1 20	.08	.04		
14	.05		.03	.75		.05	.35		2.94	1 20	2.21	.28	
15	.37	.15	.02	1.50	a	1.85 a	.03		30	2.00		1.46	
16	.14			.01	.02	.06				.55	1 69	.17	
17	.08 a	.10		.20 a		.53		.58		.55 f	.03 f	.50	
18			a			.08		.03	.14 f	.47	.79	.59	
19	a	a .04			.11	.18		.10 f	.14	.30	.04		
20		.80	.20	.06	.09	.16	.10 f		.13	4.00			
21		.21	.01		.02			.01		.21	.08		
22			.06	.65	.19 f	.04 f			.41	.06			
23	.79		.01	.55	.22		.40		2.24		1 05		
24	.03		.05 f	f	.33	.01	1.20		.10	.80	.11 b	.03	
25	.31 f	.08		.02	.03	.16	.03	.02			.82 b		
26	f .25	f	.04	.05	.03	.52				b	.32		
27		.20	.01		.20	.06	.14		b				
28		.20	.30		1.50	.26	b	.02			.05	.84	
29	.05		.03	.10	.87	.02 b			1.73	.40		.66	
30			.14	.27	2.28 b			.03			.31	28	
31	.13				b1.00		.30	.38		4.00		n .46	
Sum	2.96	3.18	1.30	7 50	8.17	8 89	9 07	3.25	10.29	16.62	9 01	5.21	

January 1st, to December 31st, 1862.

Days.	Jan.	Feb.	Mar	Apl.	May	June.	July	Aug.	Sep.	Oct.	Nov.	Dec.	Total
1	.04	.02			.08				a .30	.07		.09	
2	.06		.04				1.00	.04		.03			
3	1.56		.02			.02	a			2 35			
4	.02					.10 a		.47	.01	6 00	.05	.35	
5				.36	.09 a	.13	.82	.60	.07	1.27	.05		
6	.15 a				36					1.61 f	.38 f		
7	a	.14	a	a	.06	.07	.17	.15		f	.12		
8	.10	.02 a				2 00	.07	.09 f				.02	
9	.04					.15	.09 f	.10	.35				
10	.02	.04	.06					.23		2.10	.38	.49	
11	.02			.06	.06		f .01		.15			.09	
12	.10	.40				f .06				.10	1.05		
13	.15			f		.07		.04		.06	2.05		
14	.14 f	.38	.07 f		.57		.31			b	3 03 b		
15	.11				.44			.10	.13 b	.07	.60	.02	
16	f .15	.12 f				.46		.05 b		1.85	.04		
17	.05			04			.75 b	.15	1.00	.04	.70	.07	
18	.03						b .22		.06		.25		
19	.06			.06		b .29		38			.25	.09	
20	.05				b .03	.06	.06	.26	.04				
21		b	.03 b	.16		.04	.34	.30	.04	.12 n	1.20 n		
22	.05	b					.11			1.50	.70		
23	b .46			.02	.23	.03		.13 n	n			.82	
24	.74		.12	.18	.51	.02		2 65					
25	1.00			.42	.91	.45	n	2.06	.64		.02		
26					.04	.08 n		.30	.01				
27	.05				n	94	.20		.03				
28	.25 n			n	n	.75			.18		.07 a		
29					.05		.03	.30		1 60 a		.01	
30	n		n	.04				a	a	.04			
31										.07			
Sum	5.40	1.72	0.34	1.34	3.43	5 72	3 68	8 40	3.01	18.84	10.98	2.65	

RAINFALL AT "HUSBAND'S," BARBADOES.

January 1st, to December 31st, 1863.

Days.	Jan.	Feb.	Mar	Apl.	May	June.	July.	Aug.	Sep.	Oct.	Nov.	Dec.	Total
1		.37	.03	.05		f	f	1.67		.64			
2		.02	.01	.68								.35	
3		f .06		.20	f		.04		.14	.14	b	b 1.20	
4		.00					.57	.24	b		1.54	.01	
5	f	.06	f .02	.03				.80	b .15	.02	.57		
6	.01	.30		.04		.08	.37	b .10			.29		
7		.02				.04	b .04	.07	.02	.65	.30		
8			.02	.01		b	.10			.05	.30		
9	.11	.43				.46	.16	.05	.02		.29	.14	
10		.05	.10	.12	b .71			.20	.05	.06		n .06	
11		b	.09	b .03	.11		.12	.03	.16		n	.08	
12	b		b .05			.05	.10	.03	n		.08		
13				.06		.11		.05	n				
14		.11		.11		.15	.20	n		.07			
15	.02	.65		.08			n 1.35	.04	.24		1.80	.18	
16	.20	.03		.12		n	.04		.36	.31	.27	.07	
17		.05			n .10			.15	1.50		.10	a .05	
18	n	.02		n .08	.02			.15		.45	a	.12	
19	n		n		.14				.04	a .04	.58		
20		.08		.02	.02	.08			a .17		.45		
21	.04	.08		.38		.23			.17	.02	.05	.04	
22	.05	.06		.06			.45	a .02	.05	.03	.42	.50	
23	.09	.09			.03	.04	a .11		1.11			.20	
24	.07	.04				a		1.07				.04	
25	.09	a .33		.03	a	.32				.08	f .04	f	
26	a	.65		a .10		.06	.25	.33	f		.17	.05	
27	.09	.50	a			.04	.20	.48	f			.12	
28	.11	.11					.03	f .40	.08	.10			
29	.09		.29					.11	.40		.12		
30	.05		.02				f .02			.02	.47		
31	.02		.25				.05						
Sum	0.86	4 13	1.19	2.20	1.13	1.66	4.20	5.99	4.66	2.68	7.84	3.21	

January 1st, to December 31st, 1864.

Days.	Jan.	Feb.	Mar	Apl.	May	June.	July.	Aug.	Sep.	Oct.	Nov.	Dec.	Total
1	.05		b					.03	n	.05	.14	.02	
2	.40	.18					.01	n		.35	.42	.20	
3	.44	.07				.09	.33	.84		.12	.02		
4	.30					n .04	n		.12		.30		
5	.20				.18	.03			.66	1.45	.38	.02	
6	.14			n	n		.11				a .01	a .07	
7		n .05		.03			.54		.02		.02	.10	
8	.05	.04	n				.09		a		4.16	.05	
9	n .03						.02		a .10	.72	.66	.07	
10	.04		.06				.06	a .79		.03	.30	.30	
11	.03			.21			.18		.01			.30	
12		.03				a .06	a	.22	1.54	.03	.28	.45	
13	.28	.07			a	.03	.46		.33		f	f .27	
14	.10	a		a	1.20	.02		.21	1.75	4 55		.04	
15	a .08	.05	a		1.25			.10	f .40	f	.01		
16							.17	.11	.43		.15	.30	
17	.12						.50	f 1.30	.46	.61	1.24	.20	
18	.16	.20	.20		.06	.22		.32	.46	.05	.02	.01	
19	.05				.12	f .04	f .48	.06	.33	.02	.03		
20	.12	.17			.04	.04	.52	.03	.24	.39	.01	.30	
21	.28	.14		f	.01	.02	.07			.90	b .43	b .38	
22		f .32		f			1.22	.03	b .22	b 1.45	.21	.03	
23	f		f			.03	.06	.64	1.45	.15	.26	.03	
24		.05					1.31	b .13	1.23	.56	2.41		
25		.09					b .75	.56	.06				
26	.03	.08				b	.06	2.20		.10			
27	.12					.54		1.14	.34	.82		n	
28		.06			b .03	.03	.03		.32	.20	n		
29	.05	.02		b	.03		.10				.66	.02	
30			b	.05	.01		.04	n	n			.16	
31	b							.21				.25	
Sum	3.07	1.62	0.26	0.29	2.93	1.19	7.11	8.92	10.47	12.55	12.12	3.57	

RAINFALL AT "HUSBAND'S," BARBADOES.

January 1st, to December 31st, 1865.

Days.	Jan.	Feb.	Mar	Apl.	May	June.	July.	Aug	Sept.	Oct.	Nov.	Dec	Total
1	.03	.25		.08		a .19	a	.53			1.10	.10	
2		a			a		.36	.17	.03	.02	.03	f .16	
3		.05	.07	a		.90	.88	.18	.31	3.85	f	.14	
4	a .10	.04	a			.91	.55	.18	.11	f .15	.06		
5	1.10			.01			.15	.75	f .24	.02	.03		
6				.02	.05			.04		.09	3.25		
7		.05	.01		.07	.30	.43	f .05	.08	1.40			
8		.14		.50	.15	.10	f .08		.30		.01		
9				.29	1.42	f	.03	.02		.55			
10		f		.15	f .15			.53	.03		b	b	
11	f	.07		f	.26	.02		.22	.45	b .13			
12			f		.26		.29	.27	b	.56			
13			.03		2.45	1.20	.01	b .41	.18	.35		.05	
14	.03	.01			.08	.58	.14	.58				.39	
15	.56	.02		.10		.15	b .70	.05				.17	
16			.50		.70	b 1.58	.17	1.91				.11	
17		.04	.08	.05	1.25	.42	.04	.01				.13	
18	.16	b	.01	b .07	b .02	.48	.04	.03			n	n	
19	.03			.30		.15	.80	.04	n .88	n .20	.16	.43	
20	b .03		b			.54	.01	.03		.96	.04	.39	
21	.06					.05		n .75		.82	.38	1.65	
22	.05	.70			.02	.01	n .06	.35			.41	.04	
23			.01	.13	.12	n .03	.12	.09		.21			
24			.39	.04	n		.17	.36		.20			
25		n	.22	n .17			.38	.03		.20	.05	a .23	
26				.04	.04	.09	.50	.45	.37	.03	a		
27	n	.07	n	.11		.68	.04	.32		a .03			
28				.02	.29			.07	a .02	.21			
29					.05	.17		a	.28	.50		.52	
30	.77		.05		.10	.53	a	1.03	.05	3.25		1.41	
31	.02				.29		.10	.37		2.69		0 28	
Sum	2.94	1.44	1.37	2.08	7.77	9.08	6.05	9.80	3.33	16.42	5.52	6.20	

January 1st, to December 31st, 1866.

Days.	Jan.	Feb.	Mar	Apl.	May	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.	Total
1	f .21		f				.03	.03	.79	.06		.54	
2	.16	.03				.11	.70	b		.29	.14	.91	
3	.20					.11	.07	b .38		.45	.14	.39	
4			.04				.50	.04	.13	.15	.30	.95	
5		.04		.11		.03	b .01	.11	.01	.77		.10	
6	.03	.14			.03	b	.29	.04		.01		.09	
7		b			b .67			.01	2.30	.26	n	n .24	
8	b .09	1.00		b			.21	.03	.05	n .31	.06	.04	
9		.26	b				.41	.03	n .03				
10	.03	.11				.05	.05	n .76	.07		.20	.49	
11	.07	.10			.01	.02	.12	1.45		.60	.01	.76	
12		.30	.43			n	n 2.40	.43		.10	.04		
13		.34					.10	.01			1.84	.75	
14	.09	.01	.21		n		.30		.04			.15	
15	.39	n .02	.30	n .11	.30				.01	a	.02	a .12	
16	n .03	.10	n	.37	1.03	.01	.33	.17	.03	a	.06	.08	
17	.54						.03	.07	a .02		.06	.19	
18					.13			a .05	.15	.18		.03	
19	.04		.07	.02		a .08	a .41	.01	.06	.82	.01		
20	.03	.01	.06	.13			.55	.43		.66			
21	.04	.02	.07	a .01	a		.01	1.25	.31		.10	f	
22	.38	a .02			.05		.16	.73	.01	.11	f .40		
23	a	.07	a .03	.18				.39		.06	.71		
24	.02				.05	.25	.01	.30	f	f .35	.01		
25			.04			.25	.14	2.10	.64				
26	.09		.06			.23	.06	f		.17			
27					.01	f	f .01	.49		.05			
28					.21						.07	b	
29			.01	f	f	.08			.15		b .63	.50	
30	f		.19	.05		1.55	.18	.55	.08	b	.31	.11	
31			f				.07		b	.40			
Sum	2.44	2.57	1.51	0.98	2.49	2.77	7.15	9.86	4.88	5.80	5.11	6.44	

RAINFALL AT "HUSBAND'S," BARBADOES.

January 1st, to December 31st, 1867.

Days.	Jan.	Feb.	Mar	Apl.	May	June.	July.	Aug.	Sep.	Oct.	Nov.	Dec.	Total
1			.01	.02		.13	n .12	.21		.01		.02	
2	.40	.12	.17	.13	.43	n .18	.03	.11		.09		.10	
3	.16		.03	.05	.07	.05	.16	.18				1.67	
4	.03	n		n .10	n .22			.21	.06	.04	a .65	a .08	
5			.02	.10	.21	.08	.04	.03	.67	a .23	.01	.07	
6	n		n .03	.22	.01	.44	.14	.83	a .01	2.62			
7	.02			.20		.77	1.55	a .51	.50	.79			
8	.20			.03	.06	.67	a	.01	.45	.01		.93	
9					a		.12		.21	.12	.68	.09	
10		.08	.02	.04	a		.41	.02	.04	.48	.03	.05	
11	.03	.02		a		.03		.45		1.00		f .01	
12		a				.09	1.21		.17	.09	f .36		
13	a .08	.07	a			.53	2.01		.46	f	.03		
14	.16	1.20	.01	.01		.03		.13	f 1.04	.32	.97		
15	.01	.79		.08			.06	f .01	.01	2.90	.25		
16		.78	.01	.35		.05	f .12	.06	.27				
17		.01		.54	.10	f .10	.07		.06	.06		.02	
18		f .32	.07		f .03	.01	.41	.01		1.25	b	b .03	
19		.01		f .21		.06	.07	3.10	.80			.10	
20	f		f		.07	.10		.11	.01	b .16			
21	.20				.13				b .64		.08	.05	
22	.36		.14			1.94	.14	b .08	.13	.01		.34	
23	.29				.16	.01	.11		1.40			.06	
24	.01	.30				.15	b .07		1.68				
25	.38					b 1.69	.08	.59	.56			n .03	
26		.05			b .05	.67	.67	1.21	.15		n	.01	
27	b .01		.01	b .02	.01			.82	.36	n .25	.30	.06	
28	.01	b .07	b			1.20			n .04		.14	.02	
29			.01		.01	.48		n .06			.05		
30	.35				.15	1.17	.01	1.22				.03	
31	.43		.09		.09		n .28	1.24				.11	
Sum	3.13	3.82	0.62	2.10	1.80	10.63	7.88	11.20	9.72	10.43	3.55	3.88	

January 1st, to December 31st, 1868.

Days.	Jan.	Feb.	Mar	Apl.	May	June.	July.	Aug.	Sep.	Oct.	Nov.	Dec.	Total
1		a .17	a			.21	.01	.04	f 3.00	f			
2	a .13	.01				.01			.56	.18			
3	.02	.01						f .04		1.10	.04	.11	
4	.03			.05		.04	f	.03	.04				
5	.61			.01	f				.03		.37		
6		.13		.01	f		.22			.22	.10	b	
7		.01		f	.03		.03		.06	.10	b .20	.02	
8		f .11	f	.07	.08	.10	.05	.16	1.17	1.35	.02		
9	f	.16	.01	.03	.03	.04		.01	b	b	.13		
10	.10					.50	4.77	.13			1.75		
11	.14		.01				.06	b .03			.01		
12		.02					b .01				.01		
13	.01	.03	.31	.01	1.29	b	.04	.93			.01	n .22	
14	.18	.16	b	b	b	.05	1.24	.15		.04	n .03	.02	
15	.25	b	b				.01	.17	06	n .15			
16	.12		.03					.02	n	.09		.12	
17	b			.06			.07			.08		.04	
18	.07		.02	.01		.07		n .09	.07	.06			
19	.01			.13			n .10			.31			
20	.01					n .04	.30	.03	.15		.05	.20	
21	.17					.42			.64	.01		a .30	
22	.08	.19	.01	n .19	n	.02				.08	a		
23		n	.04		.04	.14	.20	.03	a .27	a .10			
24	n .05	.01	n .20	.15	.03	.17		a		.18		.02	
25						.17		.08	.21	.27		.04	
26						.01	a .01	.02	.22	.76			
27	.03		.02	.05		a .09	.06	.37	.72	.12			
28	.12				a	.11	.20		.02	.41	.01		
29	.13		.12	a		.63	.04	1.60	.31		f	f	
30	.12		.07		.04		.17	.01	.87			.01	
31	.71		a				.01			f		2.50	
Sum	3.09	0.96	0.89	0.77	1.54	2.82	7.60	3.94	8.40	5.61	2.75	3.60	

RAINFALL AT "HUSBAND'S," BARBADOES.

January 1st, to December 31st, 1869.

Days.	Jan.	Feb.	Mar	Apl.	May	June.	July.	Aug.	Sep.	Oct.	Nov.	Dec.	Total
1		.10	.01	.28	.02	.09		.31	3.07	1.30	.01	2.45	
2		.52	63		.03	b 1.20	b 1.05		.27	1.20			
3	.04	b .11	.01	b	b .04	.03	.08	.06		n	n		
4	.02	.11				.16	.06				.29		
5	b .03		b			.75		.24	n	.22	.10		
6	.26					.02			n				
7	.07		.05		.19	.21		n					
8							.04				.01	.75	
9	.05				.09	.14	n .49	.03	.17			.34	
10			.01			n .09	.03	1.66	.02		a		
11	.06	n	.22		n	.03	.63	1.90		.18	a .01	1.23	
12	n			n	.01	.07	.11	.08	a	a .47			
13			n	.02		.02					.11	.15	
14		.17	.06			.37	.01	a .03	.07	2.60	.05	.29	
15			.04		.16	.09						.03	
16						.02	a .20			.04		.01	
17	.27					a .01			.01	.30	1.73		
18	07			.04	a .04			.07		.01	.12	f	
19	.14	a		a		.06	.12	.01	.03		f .01	.03	
20	.06	.01				.02			f 1.45	f	.02	.03	
21	a .01		a			.24	.01			.84			
22	.01	.09		.02			.19	f .01	.04	.43		.08	
23			.03		.05	.01	f .32	.35	.22	.18	1.20		
24		.03				f		1.20		.01	.03		
25	.06	.02		.04	f .46	.11		.05	.40	.11	1.20		
26		f .01	.01	f 1.55	.19	.04	.10	.39		.35	b	b .02	
27	.15		f .02	.67		.06			4.56	.20		.37	
28	f .13				.06	.04			b	b 4.10		.02	
29					.16	.01	.26			.01	.01	.19	
30	.02				.20		.01	b .11		.03	.05	.01	
31					.19		b .01						
Sum	1.45	1.17	1 09	2.62	2.21	3.70	3.60	6.52	10.28	12.58	4.95	6.00	

January 1st, to December 31st, 1870.

Days.	Jan	Feb.	Mar	Apl.	May	June.	July.	Aug.	Sep.	Oct.	Nov.	Dec.	Total
1	.25	.03		n			.01		.12	a		.45	
2	n		n			.87			a 1.50	.69	.01	.05	
3	.14						.05	.01			.04		
4	.17	.01		.02	.32		.68	a .34		.02	.49		
5	.06	.23						.35	.88	.02		.13	
6						a .09	a .01	.02	2.30			.10	
7			.01			.07		.02		1.81		.01	
8	.05	a .10	.15		a	.14	.01	.24	.17	f	f		
9	a .01			a .04		.16	.07	.05	f	f .71	.45		
10	1.30	.02	a	.01		.05	1.61	.83					
11	.30		.02				.02	f				.02	
12	.39						f				.45	.32	
13	.40					f .14	.06	.25					
14	.01	.37		.19	1.20	1.38	.25	.32		.31	.09	.06	
15	.60		.09	f	f	.04	.26	.13	.11	.12		b .04	
16		f .09			.17	.27	.68			.70	b .21		
17	f .25	.01	f .04		.35		.15		.55	b .66			
18	.05	.03	.01	.18		.01		1.80	b	.60			
19	.13	.06						b .19	.15	.45		.01	
20		.16		.01	.10	b	b .16		.09	.26		.10	
21	.03	.05		.06	.31	.12			.05	.39	.12	.25	
22	b		b	b	b .01	.10		.70		.13	.12	n .18	
23	.11	.03			.16	.90	.19			3.00	n .27	.23	
24	b		b		.09	9.00	.28	.14		n 1.30	.59		
25	.26			.01	.07	.02	.18	3.32	n		.95		
26	.11		.01			.06	.01	n	.06		1.05		
27	.13					.01			.13		.54		
28	.01				n	.06	n		.03	.03	.10		
29	.01				1.49	.10	.05	.28	.04		a .03	a .72	
30				n	n .23		.30		.01	.08	.25	.15	
31	n .02							.05		a 1.64		.74	
Sum	4.78	1.18	0.33	0.52	4.50	13.59	5.03	9.04	6 19	12.92	5.76	3.56	

RAINFALL AT "HUSBAND'S," BARBADOES.

January 1st, to December 31st, 1871.

Days.	Jan.	Feb.	Mar	Apl.	May	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.	Total
1	.21	.67	.01			.17	.02		.36				
2		.03			.01		f .99	.20			.04		
3		.05		.01	.03 f	.06	.05	.01	.09		.30	.06	
4		.01	.02	.07 f			.18	.84				.40	
5	.01 f			f	.09		.07	.18		b		b	
6	f					.01	.09		b	b .02			
7			f	.01		.16	.26	.13		.17	1.26	1.11	
8						.20		b	.12		.19		
9						.39	b	3.15	.05		.20	.16	
10		.11	.51		b				.10	.02	.05		
11	.15	.05		b			.02	.07	.72	.64	1.12	.85	
12	.49	b .06		b		.03	.02		.67	.22	n .03	n .24	
13	.03	.04	b			.16		1.54	1.20	.16	.24		
14	b .50						.20	.31	n	n .48		.01	
15	.19	.05					.20	.05		.05			
16	.60	.10	.09			.12		n	.33	.68	.03		
17	.20	.09					n			.50		.05	
18		.03	.71		n	.11	.03		.15	.06		a .04	
19	.05	n	.01	n	n	.29	.17	.03	.40	.03	a .03		
20	.03					.02	.01	.17	.10	a .09	.01	.09	
21	n .40	.01	n				.08	.10	a	.01	.15	.20	
22	.08			.05		.16					.08	.21	
23	.02	.09				.01		a .09		.83			
24	.12	.05	.35		.78	.20		.05		.15	.16		
25	.04	.01	.05		.02	a	a	.11		.21	.02		
26	.69		.02		.02	.11	.02	.03	.11		.24	f	
27	.05	a		a	a		.65	1.47		f			
28	a .32	.06			.35	.01	.02		f	.07 f			
29			a					.41	.17			.01	
30	.11					.15		f .45	.17	.18	.38		
31	.05				.03		f .01	.21		.03			
Sum	4.34	1.51	1.77	0.14	1.33	2.36	3.09	9.60	4.81	4.53	4.53	3.42	

January 1st, to December 31st, 1872.

Days.	Jan.	Feb.	Mar	Apl.	May	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.	Total
1				b	.02	.09					n .05		
2		b	b					.02		n	.15	.05	
3	b							.14	n	.32		.32	
4	.16	.62					.27 n		.06	.10		.02	
5	.04	.18			.05	.01	n				.73	.08	
6	.11	.32			n	.35	.18		.03	.11	.40		
7		.04			n .35	.24			.04			a .02	
8		.07		n			.07	.42	.39	.51	a .14		
9		n	n				.16		2.08	a		.05	
10	n .36	.70				.01		.01	a	.27	.63		
11		.02							.01	.68	.25		
12	.05	.01		.02		.01		a .30	.01	.03	1.50		
13		1.05	.05	.01			a	.09			1.10	.01	
14		.15			.27 a	.14		.09			.14	f	
15			.05	a	a .02			.04		.15	f		
16		a					.03	.24	.01	f			
17	a		a .03			.32		.12	f	.01	.05		
18	.18						.38	f .16	.07		.40		
19	.02		.02			.05	.11	.08			1.74	.03	
20	.02		.07			.06	f 05		.02		.14		
21	.02			.07	f	1.60		.03	.07		.05	.31	
22			.17	f		.05		.13	.02		.05	.04	
23	.05		.22	f						b	.15	b .14	
24		f	.15						b	b	.36	.05	
25	f		f .01					b	.20	.35	.10	.26	
26			.01		.37	1.20		.05	.01	1.05	.15	.16	
27					.05	b	b .01	.05	.16		.17	.11	
28	.03					.10			.07		.01	.16	
29					b			.05				.41	
30				b	.47					.20	n	n 2.63	
31					.23		.19	.01		.13		.13	
Sum	1.04	3.16	0.78	0.10	1.83	4.23	1.45	2.03	3.25	3.91	8.46	4.98	

RAINFALL AT "HUSBAND'S," BARBADOES.

January 1st, to December 31st, 1873.

Days.	Jan.	Feb.	Mar.	Apl.	May	June.	July.	Aug.	Sep.	Oct.	Nov.	Dec.	Total
1					.72		.11 a				.61		
2	.01	.01		.03	.06	a			.05	1.20	.65		
3	.05	.01				a .03	.03	1.26					
4	.12 a	.31		a .07 a				.52	.01	.62 f		f .07	
5	a .01	.03					.26		.06	.59	.08	.06	
6	.71	.09 a	.07				2.73		f	f		.54	
7	.11	.10	.15			.02		.91				.25	
8	.05	.05					.10 f		.05	.54		.14	
9	.80		.03				.15		1.28			.12	
10	.09					f .05 f		.68	3.09	.20		.04	
11				.13	.06			.75	4.80	.27		b	
12		f		f 1.00 f		.05	.07			1.20 b		.04	
13	f	.54					.22		b	b			
14	.06	.16 f									.05		
15	.14					.05		b	.18	6.30			
16		.02			.14	.05	.15	.02	1.11			.01	
17	.01				b	b	.50	.08	.02			.37	
18	.11		.03				.11		.03				
19	.15		.02		b .07	.15	.03		.07		.10 n	.06	
20		b		b					.17	.09 n			
21	b		b					.11 n	.03 n				
22						.27	.08	.46	2.20	.13	.02	.05	
23	.73			.01		.04	.50 n	.32		.76			
24	.03				n		.14		.02	.33			
25	.04		.01		.20	n		.11		.21		.11	
26	.20		n	n	.07			.30		.23	.10 a	.06	
27	.03 n		.06		.25		.15				a .03		
28	n		n		.25			.01		.28			
29						.08		.10 a	.05 a	.02	.03	.17	
30					.06	.01		1 20		.24		.01	
31	.10						a	.20	.13	1.08		.05	
Sum	3.55	1.32	0.37	1.24	1.88	0.08	5.41	7.03	13.35	14.29	1.67	2.15	

REPLY TO DR. T. STERRY HUNT.

By F. A. Genth.

(*Read before the American Philosophical Society, July* 17, 1874.)

Dr. T. Sterry Hunt has published in the Proceedings of the Boston Society of Natural History, Vol. XVI., March 4th, 1874, an article, entitled: "*On Dr. Genth's Researches on Corundum and its associated minerals,*" in which he charges me—*in common with many others*—of having *fallen into errors* and of having been *led to conclusions wholly untenable,* for a *lack of a clear understanding as to replacement, alteration and association in the mineral kingdom.*

He then gives an outline of the manner in which the various alterations in a mineral species may take place, by replacement, envelopment and epigenesis with examples for each, and dwells at more length upon the fallacy of considering the alterations of many minerals and rock masses as the *result of an epigenic process; a doctrine which has been embodied in the dictum of Prof. Dana*: "*regional metamorphism is pseudomorphism on a broad scale.*"

He then refers briefly to the results of my investigation on corundum, in which I have shown that by "epigenic" pseudomorphism this mineral has been altered into numerous more complex species and rock masses—and winds up by stating that he *not only has carefully studied*

my paper, but had also *examined the extensive collection of specimens upon which my conclusions were based*, and that—*all the phenomena in question are nothing more than examples of association and envelopment, and that the corundum-bearing veins had their parallels in the granitic veins with beryl and tourmaline in the White Mountain rocks, and the calcareous veinstones with apatite, pyroxene, phlogopite and graphite of the Laurentian rocks.*

I may be permitted to say a few words in reply to Dr. Hunt's assertion, that I had fallen into errors and had been led to wholly untenable conclusions.

When I had the good fortune to obtain a few years ago the *first real* pseudomorph after corundum—the spinel from India, and afterwards brought together numerous specimens of analogous alterations, showing from the *same* locality crystals of corundum without any, and others representing all stages of alteration from a thin coating to the complete disappearance of every vestige of corundum, and when I proved that such changes have resulted in the conversion of corundum into about two dozen mineral species; I could not understand how any unprejudiced mind could arrive at any other conclusions, but that these extraordinary occurrences which I have described, were the result of epigenic pseudomorphism.

This opinion has been adopted almost without exception by all who have had an opportunity to examine my specimens, or who have studied my paper. If Dr. Hunt differs from me, I certainly will not deny to him the right to believe what suits his own notions, but when he boldly charges me with having committed errors, I want better proofs than a repetition of his views, with which we were familiar long ago. He certainly has not a single fact which could show the fallacy of my conclusions, or he would have produced it.

The corundum alterations have nothing in common with the Fontainebleau crystals, or with stanniferous orthoclase; the green and red tourmalines from Paris, Me., or the beryls filled with orthoclase, or the zircon and galenite filled with calcite, and cannot be explained *rationally* as examples of *association* and *envelopment*.

To give strength to his statements, however, Dr. Hunt says that he had "*examined*" with me "*the extensive collection of specimens upon which my conclusions were based.*" When Dr. Hunt favored me with a visit, I was in hope that he *would examine* my specimens, but his time was so short that he saw only about one-third of them, and the "*examination*" (*!?*) of these was finished in about *five minutes*.

As to his last sentence, I must confess that I am unable to discover the least parallelism between the corundum-bearing veins and the granitic veins, with beryl and tourmaline, so common in the White Mountains, and the calcareous veinstones with apatite, pyroxene, phlogopite and graphite of the Laurentian rocks;—but can see in the former nothing but

the product of a partial, and in many instances of a pretty thorough alteration of the original corundum into micaceous and chloritic schists or beds, or, as Prof. Dana would express it: "*a pseudomorphism on a broad scale.*"

UNIVERSITY OF PENNSYLVANIA, July 4th, 1874.

CONTRIBUTIONS FROM THE LABORATORY OF THE UNIVERSITY OF PENNSYLVANIA.

NO. II.

ON AN IMPROVEMENT OF THE BURETTE VALVE.

BY GEO. A. KOENIG, PH.D.

(*Read before the American Philosophical Society, August* 21, 1874).

Strictest simplicity of construction must be considered as the first requirement of any tool or apparatus, besides fitness for all work within its sphere of action. Frequently we meet with constructions in which fitness has been sacrificed to a considerable extent for the sake of simplicity, and quite as often the reverse. There are cases, indeed, in which circumstances demand even a certain degree of one-sidedness, but in my judgment a more complicated apparatus, overcoming defects of working attached to a simpler device, is practically the more desirable of the two.

When Frederick Mohr gave his rubber tube valve to volumetric analysis, he had indeed hit, like a true genius, upon the simplest contrivance imaginable. To this piece of apparatus must be ascribed the rapid adoption of volumetrical determinations by analytical chemistry. No matter how simple the volumetrical reactions might be, if they had to be executed by an unhandy manipulation, the practical chemist would rather keep on with his accustomed precipitations and weighings.

Let us consider now the conditions under which the burette will satisfy all demands which can be made upon it.

1. *The instrument must not engage the hands of the operator during the operation.*

This condition requires the burette to be fixed and its position to be quite independent from the person of the manipulator.

2. *The instrument must allow a rapid discharge of its liquid contents to any desired volume, without the application of another force than that of gravitation.*

This condition requires the tube to be fixed vertically and to be furnished with a valve.

3. *The valve must allow to interrupt the current instantaneously and completely, and also the regulation of the liquid current from the smallest drop to a full stream.*

4. *The working of the valve must be easy, not require any effort on the*

part of the operator, by which the latter's attention is necessarily detracted from the observation of the reaction.

5. *The apparatus must not come out of order easily under ordinary circumstances and attentive manipulation.*

6. *The instrument must be applicable to all solutions used in volumetric determinations.*

The present forms of the burette are of two types: a, the *dropping burette*, which in its simplest form is a graduated, lipped glass vessel, from which the solution is poured out by the lip.

Gay-Lussac improved this primitive instrument by the appendage of a capilar tube, which although preventing a sudden stream, when but a drop is wanted, still does not come up with the above given conditions except the last, and is altogether an unhandy piece of apparatus.

b, *The valve burette.* The very imperfect instrument just mentioned stimulated invention, and we find as the next step the graduated tube fixed to a stand vertically, and furnished with a glass ground perforated stop-cock. This instrument is very nearly perfect. if well executed, but from the nature of things it cannot fill the conditions 4 and 5. The rough surface produced by grinding is exceedingly disposed to capilar action and soon the effects from this show themselves by a layer of crystals cementing the cock completely. These working defects are, however, so well known, that I need hardly dwell any longer upon them. The same applies to Geissler's glass-rod stopper.

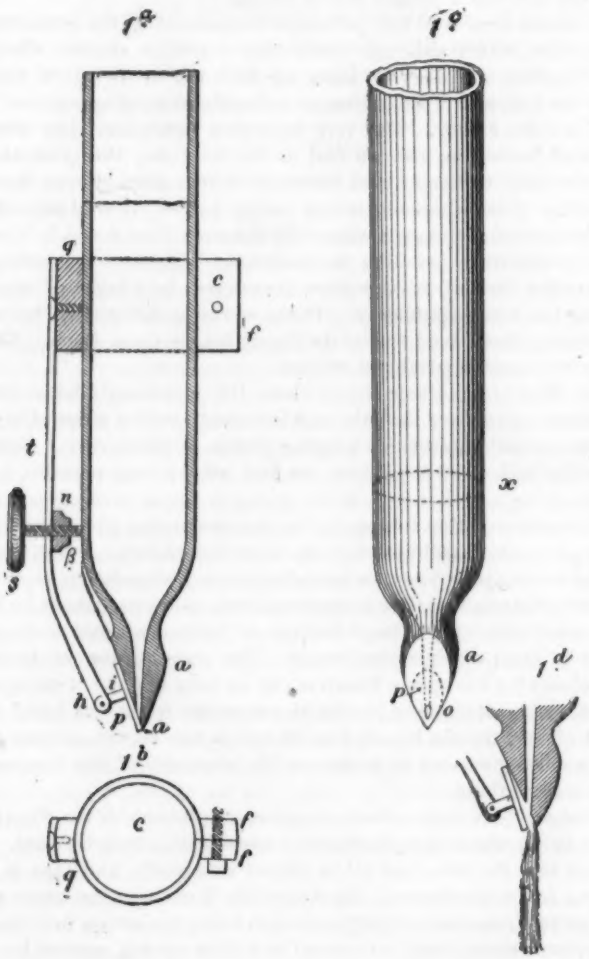
Then, Mohr showed how simply these difficulties could be overcome by connecting the neck of the tube and the mouth with a piece of India rubber tube pressed together by a spring clamp, or pinch cork. Comparing this device with the 6 conditions, we find, after a long practice, that it is far from being satisfactory. If the spring is strong it requires a remarkable muscular exertion to open it, besides destroying the elasticity of the rubber; if weak, it will not close the valve completely. I find, moreover, that the rubber tube becomes soon deteriorated chemically, especially by alkaline solutions, and that many volumetric solutions cannot be brought into contact with such a large surface of rubber without undergoing a change in their docimastical value. The substitution of Hoffmann's screw clamp for the spring clamp is not so very happy; it requires both hands for the adjustment just in the moment when one hand is most needed for stirring the liquid, besides it acts too slowly, several turns of the screw being needed to overcome the elasticity of the comparatively thick rubber tubing.

J. Blodget Britton described an apparatus (Journal of the Franklin Institute, 1870,) which is undoubtedly a considerable step forward. He recognized that the valve had to be placed externally, and that it had to possess a screw movement. He draws his burette at the lower end into a capilar tube, bends it slightly, so as to bring the orifice in contact with a cork plate, which itself is fastened to a steel spring, opened by a screw bolt. To prevent splashing, the opening must be very narrow, and con-

sequently the emptying of the burette requires a considerable extent of time. But otherwise the apparatus is quite perfect and neat in its execution.

I shall proceed now with the description of a device, which has realized my expectations as to the possibility of combining the advantages of Mohr's principle with universal applicability and convenience of handling.

1, *The burette.* I take a Mohr burette tube, as it is furnished by the

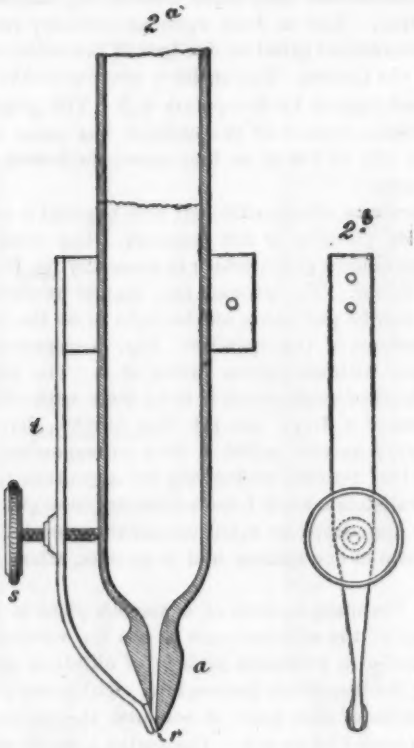


trade, hold the inflated part of the neck (serving for a hold to the rubber) over a Bunsen flame and let it contract slowly at a dull-red heat, until the channel has become capilar as shown in figures 1a, 1c and 2a of the accompanying plate. It needs hardly to be remarked, that during the process, the tube has to be kept revolving, and allowed to cool slowly. The glass wall has become very thick and strong, facilitating the next process of grinding. This is done upon an ordinary rotary grindstone in from 8 to 10 minutes. I grind off one-half of the inflation at a steep an gle, as shown in the figures. The orifice is not required to have a definite size and is naturally given by the points α, β. The grinding is continued until the elliptic section of the channel has come with its lowest point from about 1-16 to 1–8 of an inch above the lowest point of the inclined ground plane.

A very short practice affords sufficient skill to grind a very nearly plane surface. Absolute planeity is not required. The sides and back are ground next to produce a point, which is necessary for the letting out of small drops of liquid. The ground face stands at right angles to the graduation and may be put either on the right or on the left side, according to the convenience of the operator. Fig. 1c represents a front view of the ground face, with the capilar orifice at 0. The size of the latter depends on the kind of work which is to be done with the burette, as it influences the size of a drop. On my 20cc burette, divided into twentieths, I have a very narrow orifice, a drop corresponding to one-half a division. I use this burette exclusively for argentum nitrate solution. For ordinary alkalimetric work I use a burette (50cc) graduated into one-fifths and allow the drops to equal one-tenth cubic in. This opening empties the burette in one minute and a quarter, when running at full stream.

2, *The valve.* Platinum in form of a smooth plate is not acted upon materially by any of the solutions now in use for volumetrical analysis. The valve consists of a platinum plate p of elliptical shape, $\frac{3}{8}$ and 3-16 of an inch being the respective parameters. Thickness about 1-32 of an inch. To the centre of this plate is soldered the platinum stem i, the end of which is pierced by an eye. The spring t, made of brass or German silver and platinated, is screwed to the clamp c, and has a fork at its other end for the insertion of the platinum stem i, forming thus the hinge h. It carries a nut n, through which the screw s passes. In order to open the valve, the screw head is turned, when the screw bolt comes into contact with the glass tube and forces the spring backwards. The valve plate assumes then a position as represented in figure 1*d*, allowing the full stream to run straight downwards without the least splashing. The capilar orifice being elliptical, with its long axis parallel to the stream, it is evident that by reversing the screw, the orifice will close gradually, the lowest point the last, allowing a most complete regulation, and when once reduced to dropping a quarter of a turn of the screw will close totally. The only objection to this arrangement of the valve, which has presented

itself thus far, is the delicacy of the hinge. Yet I have had one in use constantly for six months past, and it works as satisfactorily as on the first day. In the hands of beginners it may come out of order sooner. The clamp *c* is made of brass tubing, with the flanges *f f* and the block *g* sol-



dered on. It is made sufficiently large to admit of variation in the diameter of the burette tubes, a strip of paper being used as a filling. The delicacy of the hinge, and to some extent the cost of the apparatus ($2.50) have prompted me to substitute a simpler construction.

Figures 2*a* and 2*b* represent this device.

The platinum plate is replaced by a piece of pure rubber sheeting, the thickness of strong paper $\frac{1}{8}$ by 3-16 of an inch, which is attached to the end of the spring by means of a solution of rubber. The lower part of the spring may be rendered proof against chemical action by galvanic platinum plating, or by a coating of rubber. The former is certainly the best, but I found by several months' experience, that a spring coated

with rubber, will resist the action of standard acids, and shows no sign of oxydation and dissolution. The rubber coating is done very quickly with a concentrated chloroformic solution. The dipping in and drying is repeated several times. I have furnished now all the burettes used by my students with this simpler contrivance ($1.00) and have found my expectations more than realized. The surface of contact between the rubber and the standard solutions is so small, that a deteriorating influence on the latter could not be noticed.

I must acknowledge my obligation to Mr. J. Zentmayer, the well-known optician and mechanician, of this city, for the practical execution of my ideas and for many valuable suggestions in the course of my experiments. Any further information that may be deemed necessary shall most gladly be given.

CONTRIBUTIONS FROM THE LABORATORY OF THE UNIVERSITY OF PENNSYLVANIA.

No. III.

ON AMERICAN TELLURIUM AND BISMUTH MINERALS.

By F. A. Genth.

(*Read before the American Philosophical Society, August 21st*, 1874.)

On several occasions I have given descriptions and analyses of tellurium minerals, which have been found associated with the gold ores of this country. Since my last paper on this subject (Amer. Journ. of Science [2] XLV., 306–319) several highly interesting discoveries have been made, which not only augment the list of species, but also corroborate some of my former observations.

Most important is the occurrence of the tellurium ores at the Red Cloud Mine, near Goldhill, in Boulder County, Colorado. Prof. B. Silliman (Journ. of Science [3] VIII. 25–33), has given a very accurate and careful description of some of the minerals found at this locality, and an exceedingly interesting account of the geological position of the vein.

Through the liberality of my friend J. F. L. Schirmer, Esq., Superintendent of the United States Mint at Denver, Colorado, I have been put in possession of a considerable quantity of very pure and excellent material for investigation, including several varieties not mentioned by Prof. Silliman.

Another interesting locality of tellurium minerals is the Briggs or King's Mountain Gold Mine, sometimes called the Gaston Mine, in Gaston Co., N. C., where I noted this occurrence about two years ago.

A third one is in the neighborhood of Highland, Montana. Several others of minor importance will be mentioned under the different species.

The following are the results of my investigations:

1. Native Tellurium.

The occurrence at the Red Cloud Mine is fully described by Prof. Silliman. I have observed it on several specimens in small, very indistinct crystals, with rounded edges; also in one splendid cleavage piece, showa plate of $\frac{5}{8}$ of an inch in length, and nearly $\frac{1}{2}$ of an inch in width, from which I have obtained a hexagonal cleavage crystal of $\frac{5}{16}$ of an inch in length, and $\frac{1}{4}$ of an inch in thickness. Generally it is disseminated in fine grains through quartz, cleavage perfect, color tin-white, inclining to gray.

Associated with sylvanite, altaite and pyrite.

Without destroying my best specimens, I could not get enough of pure material for analysis.

2. Tetradymite.

The sulphurous variety of tetradymite has been observed at several new localities: associated with gold ores in small lead-colored scales at Spaulding Co., Georgia; also in York District, S. C.; in quartz from the gravel deposits of Burke and McDowell Counties, N. C.; in gray quartz with gold at the Montgomery Mine, Hassayampa District, Arizona; and at the "Uncle Sam's Lode," in Highland District, Montana. At the latter place it is found associated both with quartz and gold, and in dolomite. Part of it is oxydized into montanite. The latter, however, is not in a state of sufficient purity for analysis. That the tellurium is present as telluric acid, and not as tellurous acid, is proved by the large evolution of chlorine, when it is heated with chlorhydric acid.*

The tetradymite occurs here in considerable quantity, in foliated masses with foliæ sometimes $\frac{3}{4}$ of an inch in width and scaly-granular. Its color is between lead-gray and iron-black. It is often tarnished with pavonine colors.

The gold, which is often interlaminated with it, shows the striation of the tetradymite, and is evidently the result of its precipitating action upon the gold in solution, in the same manner as already stated in my notice of the pseudomorphous gold after tetradymite from the White Hall Mine (Amer. Journ. of Science [2] XXVIII., 254).

It is an interesting fact that the tetradymite from Uncle Sam's Lode contains sulphur as an essential constituent, while that from the gold placers of Highland, which I had received from Mr. Kleinschmidt, and described in the Journal of Science [2] XLV., 316, is *free* from it.

My friend Mr. P. Knabe has made some very important observations on this subject, which are contained in his letter, dated Highland, Mon-

* I notice the following misprints in Dr. Burkart's paper, "Uber das Vorkommen verschiedener Tellur-Minerale in den Vereinigten Staaten von Nord-Amerika," Leonhard & Geinitz Neues Jahrbuch der Mineralogie, etc., 1873, page 491, line 5 from bottom: *Tellursæure* instead of *Tellurige Sæure*, and on page 492, line 15, *Tellurige Sæure* instead of *Tellursæure*.

tana, Dec. 26th, 1870, of which I translate that part which refers to this subject. He says:

"*I have discovered the tetradymite which I sent you in* Uncle Sam's Lode, *in Highland District. Two years ago I examined a fragment of tetradymite from Highland Gulch, which I found to be the* sulphurous *variety, and was therefore very much surprised to find from your pamphlet that the tetradymite from Highland Gulch examined by you was the variety* without *sulphur. After I had repeatedly examined pieces of the said mineral, I made the discovery that* both varieties *of* tetradymite *are found together in Highland Gulch. This was the more interesting, since there occur in it also two different varieties of gold, which fact gives pretty conclusive evidence that the gold of the Gulch comes from* two different *formations. The finest gold of the Gulch originates undoubtedly from the garnet which occurs between the dolomite and granite. I then examined the different trial pits in the dolomite, and found in this formation at the head of the Gulch in the Uncle Sam Lode the specimens which I sent you. In the garnet rock which adjoins the Gulch on its left side, I have not yet found any tetradymite; but in a piece of garnet from the Gulch I found* gold *and* tetradymite without *sulphur. In all the samples of the sulphurous variety of tetradymite from the Gulch, as well as in that from Uncle Sam's Lode, I found a trace of selenium.*"

The following are the results of my analyses of the tetradymite from Uncle Sam's Lode:

		Broadly foliated.		Smaller scales from dolomite.
Sp. Gr.	=	7.332	—	7.542
Quartz	=	0.05	—	0.58
Gold	=	0.21	—	——
Bismuth	=	60.49	—	59.24
Copper	=	trace	—	0.47
Iron	=	0.09	—	——
Tellurium (by diff.)	=	34.90	— (by diff.)	34.41
Selenium	=	trace	—	0.14
Sulphur	=	4.26	—	15.16
		100.00		100.00

At the Red Cloud Mine, Colorado, tetradymite seems to be one of the rarest minerals. The first indication which I had of it was the observation of a small quantity of bismuth in the analysis of one of the varieties of petzite. After a great deal of search I discovered, associated with pyrite and auriferous hessite, a very few minute iron-gray scales, some of them with a bluish tarnish, which on examination proved to be the *sulphurous* variety of tetradymite.

3. Altaite.

I have discovered this rare mineral at *two* new localities—the Red Cloud Mine, Colorado, and the King's Mountain Mine, Gaston Co., N. C.

At the latter locality it is found in sugary quartz associated with gold, galenite, chalcopyrite, pyrite, antimonial tetrahedrite, and more rarely with nagyagite and a greenish micaceous mineral resembling fuchsite. It occurs in small quantities only, and is so much mixed with the other minerals, that I was unable to select enough for a quantitative analysis. It is easily recognized by its tin-white color, with the greenish-yellow hue, and its great lustre. It is found in particles showing the distinct cubical cleavage, but also finely granular. A very interesting but quite small piece shows a cleavage mass, part of which is altaite, part galenite, without any interruption in the cleavage plane, both minerals being easily distinguishable by their color.

The altaite at the Red Cloud Mine, Colorado, is found in larger masses, generally, however, very much intermixed with other minerals, especially native tellurium and sylvanite. It is associated with pyrite, siderite and quartz. Sometimes it is found in indistinct cubical crystals, apparently coated with a thin film of galenite; rarely in larger cleavage masses. I have a cleavage cube of $\frac{3}{4}$ of an inch in size of distinct cleavage: some of the planes are slightly coated with galenite. The most frequent occurrence is that in granular masses with indistinct cubical cleavage, a fracture inclining to subconchoidal and a yellowish tarnish.*

The analysis of a portion of the cleavage cube gave the following results:

Spec. Gr.	=	8.060		
Quartz	=	0.19	—	0.32
Gold	=	0.19	—	0.16
Silver	=	0.62	—	0.79
Copper	=	0.06	—	0.06
Lead	=	60.22	—	60.53
Zinc	=	0.15	—	0.04
Iron	=	0.48	—	0.33
Tellurium	=	37.99	—	37.51
		99.90		99.74

4. Hessite, Auriferous Hessite, Petzite.

Varieties of telluride of silver with variable quantities of gold are the principal minerals which give the ores of the Red Cloud Mine their value. I believe that I was the first to whom specimens of the rich auriferous variety were sent by Mr. Schirmer. These I have determined as petzite. Prof. Silliman mentions a variety (l. c.) containing 7.131 per cent. of gold and 51.061 per cent. of silver, of which he gives a very accurate description; he evidently had only this *one*, and therefore comes to the conclusion that the Red Cloud Mine contained *no* other varieties. It will be

* In Dr. Burkart's paper (l. c.) p. 487, line 12 from the bottom, read: *hexaëdrische* instead of *hexagonale*.

seen from the analyses which I give below, that there are several, from almost pure hessite without gold, up to the highly auriferous of the same composition as that from the Stanislaus and Golden Rule Mines in California.

a. HESSITE.

The pure hessite appears to be very rare. I have received only one small piece, which Mr. Schirmer distinguished as "black tellurium." It is of a dark iron-gray color, inclining to black, granular structure and uneven fracture; powder dark lead-gray; sectile. Its spec. gr. = 8.178.

It contains some cavities lined with minute crystals of pyrite and barite.

The analyses gave:

Gold	=	0.22	—	0.20
Silver	=	59.91	—	60.19
Copper	=	0.17	—	0.16
Lead	=	0.45	—	0.18
Zinc	=	trace	—	trace
Iron	=	1.35	—	1.20
Tellurium	=	37.86	by diff. =	38.07
		99.96		100.00

In all the other varieties, the difference in the appearance of the mineral is so slight that it is almost impossible to distinguish them. They all have an iron-gray color, and frequently assume by tarnishing a darker or purplish color, a subconchoidal fracture; the more argentiferous are somewhat darker, the more auriferous lighter and more brittle.

b. AURIFEROUS HESSITES.

		a, Sp. gr. = 8.789.				*β*, Sp. gr. = 8.897.
Quartz	=	0.18	—	0.13	—	0.70
Gold	=	3.31	—	3.34	—	13.09
Silver	=	59.68	—	59.83	—	50.56
Copper	=	0.05	—	0.06	—	0.07
Lead	=	——	—	——	—	0.17
Zinc	=	——	—	——	—	0.15
Iron	=	0.15	—	0.21	—	0.36
Tellurium	=	37.60	—	36.74	—	34.91
		100.97	—	100.31		100.01

c. PETZITE.

		a		*β*
Sp. Gr.	=	9.010	—	9.020
Quartz	=	0.62	—	0.05
Gold	=	24.10	—	24.69
Silver	=	40.73	—	40.80

Copper	=	trace	—	trace
Bismuth	=	0.41	—	——
Lead	=	0.26	—	——
Zinc	=	0.05	—	0.21
Iron	=	0.78	—	1.28
Tellurium	=	33.49	by diff.	32.97
		100.44		100.00

The above analyses, to which add for comparison those of Prof. Silliman and the petzite from Nagy-Ag, give the following atomic ratios between gold, silver and tellurium :

b α	=	1	:	32.7	:	34.3
Silliman	=	1	:	14	:	——
b β	=	1	:	7	:	8.2
Nagy-Ag	=	1	:	4.7	:	5.9
Petzite	=	1	:	3.1	:	4.2

From which it will be seen that gold and silver appear to replace each other in indefinite proportions, while the mixture of the two combines atom for atom with tellurium.

5. Sylvanite.

The Red Cloud Mine is the first American locality at which this mineral has been found. It was observed by Prof. Silliman, but his stock was not sufficient for a more minute description. The specimens which I have are massive, showing eminent cleavage in one direction, giving it a plated appearance. In one piece it occurs in quartz, which is penetrated by crystalline aggregations arranged in a line of over one inch in length and $\frac{1}{32}$ of an inch in thickness, resembling the real "*graphic tellurium*" from Transylvania. Its color is silver-white, with a strong gray tint; brilliant metallic lustre.

It is associated with pyrite, which, in very small crystals, is often so thickly disseminated through the mass, that it is very difficult, if not impossible, to obtain pure material for analysis.

Sp. gr. = 7.943.

		α		β		γ
Quartz	=	0.32	—	0.86	—	0.59
Gold	=	24.83	—	23.06	—	25.67
Silver	=	13.05	—	11.52	—	11.92
Copper	=	0.23	—	0.57	—	0.21
Lead	=	——	—	——	—	0.46
Zinc	=	0.45	—	0.11	—	0.06
Iron	=	3.28	—	4.84	—	1.17
Tellurium	=	56.31	—	54.60	— by diff. =	58.87
Selenium	=	trace	—	trace	—	trace
Sulphur	=	1.82	— by diff. =	4.44	—	1.05
		100.29		100.00		100.00

The atomic ratios between gold, silver and tellurium, and the combined gold and silver and tellurium are as follows :

α Au : Ag : Te = 1 : 0.96 : 6.98 — (Au Ag) : Te = 1 : 3.6
β " : " : " = 1 : 0.91 : 7.29 -- " : " = 1 : 3.8
γ " : " : " = 1 : 0.84 : 6.45 — " : " = 1 : 3.5

6. Calaverite.

I have observed one very minute specimen of this rare mineral amongst those from the Red Cloud Mine, which Mr. Schirmer sent me. It fully answers the description which I have previously given (l. c.).

It is associated with sylvanite and quartz. It contains a somewhat smaller percentage of silver than that from the Stanislaus Mine in California.

The scarcity of the material did not allow me to obtain for analysis more than 0.1654 grs., from which 0.0050 grs. of quartz were deducted. Dr. G. A. Koenig reduced 0.0332 grs. before the blowpipe, and obtained 42.32 per cent. of gold and silver, which I then separated with the results given below.

It contains :

Gold	=	40.59	—	39.76	42.32
Silver	=	2.24	—	2.56	
Tellurium	=	57.67	— by diff.	= 57.68	
Copper and iron	=	traces		—	
		100.50		100.00	

I was in the hope that I would find in the oxydized specimens of the tellurium ores from the Red Cloud Mine interesting products of decomposition, but observed hardly anything else than native gold, sometimes in very minute scales in the partly decomposed petzite, and small quanties of cerargyrite. There is also a minute quantity of what is probably tellurate of silver present, because if the oxydized minerals be treated with ammonic hydrate, and the ammonic solution be filtered and boiled, and subsequently acidulated with nitric acid, the argentic chloride be precipitated, the filtrate from this contains both *silver* and *tellurium*.

I also observed among the oxydized pieces, one which had a yellowish coating, probably montanite ; the quantity, however, was too small for any investigation other than a determination of the presence of bismuth and tellurium.

7. Tellurate of Copper and Lead—a new mineral.

This new tellurate has been discovered by Mr. P. Knabe, in the "Iron Rod" Mine, Silver Star District, Montana. He had sent me a small quantity of the same, which consisted of an apparently uniform siskin-green powder.

I had intended to make a full investigation of the same, but unfortunately it has been mislaid or lost.

However, I will give the most important part of the information about its occurrence, which I have received in Mr. Knabe's letter, dated Highland, March 26th, 1871.

"*I send you enclosed a mineral from the Iron Rod Mine, Silver Star District, Montana, which I hope will be interesting to you. The same substance apparently is found in the Silver Star District in all the veins which occur in the crystalline states. I have not examined that from the Iron Rod Mine, because I did not want to use up a portion of the already small quantity—but in a mineral of exactly the same appearance from the "Green Campbell" Mine, in the same District, I have found oxides of copper and lead and telluric acid. I shall try to obtain it from different mines in order to ascertain whether it is constant in its composition or is a mixture. In the Green Campbell Mine it is found as a thin coating upon the selvage of the footwall, whilst in the Iron Rod Mine it occurs in the fissures of the rock.*"

In the same letter Mr. Knabe mentions the interesting fact of having examined a graphite from the Harvey Lode, occurring in the dolomite, which contains 2.1 per cent. of silver.

This is the last information which I have received from Mr. K.; in it he states that in the latter part of May, 1871, he would make explorations in the wilderness, 40 miles W. of Highland.

8. Bismuthinite.

Dr. Burkart states in an appendix to his observations (l. c.) on the American Tellurium Minerals, (Leonhard & Geinitz Neues Jahrbuch, etc., 1874, 9,) that in the Las Animas Mine on the Sugar Loaf Mountain, Colorado, bismuth ores are found—either native, or in combination with sulphur and tellurium.

The few small pieces of bismuth ores which I have seen from this locality were bismuthinite, in stout columnar aggregations, in great part converted into bismuthite, but with still a large percentage of undecomposed tersulphide.

It contained a small percentage of silver, but not *a trace of tellurium.*

9. Schirmerite—a new mineral.

Massive, finely granular, disseminated through quartz; no cleavage could be observed; fracture uneven; soft, brittle. Sp. G. = 6.737; lead-gray inclining to iron-black, lustre metallic. B. B. fuses very easily and gives the reactions of bismuth, lead, silver and sulphur.

After deducting 1.00 per cent. quartz in analysis I., and 1.07 per cent. in II., the results are as follows:

		I.		II.
Lead	=	12.69		12.76
Silver	=	22.82		24.75
Bismuth	=	46.91	by diff.	47.27
Zinc	=	0.08		0.13
Iron	=	0.03		0.07
Sulphur	=	14.41		15.02
		96.94		100.00

The atomic ratios of Pb : Ag : Bi : S are very nearly = 1 : 4 : 4 : 9, corresponding with the composition : PbS, 2 Ag_2 S, 2 Bi_2 S_3, which gives

Pb	=	11.71
Ag	=	24.45
Bi	=	47.54
S	=	16.30
		100.00

It is allied to and closely resembles cosalite.

Dedicated to J. F. L. Schirmer, Esq.

P.S. Since the reading of my paper an article has appeared in the Engineering and Mining Journal, of August 29th, 1874, on "Tellurium Ores of Colorado, by Fred. M. Endlich," which I must not pass unnoticed, as it contains several statements which I cannot endorse.

The paper shows that Dr. Endlich had not a sufficient quantity of pure material for his examinations, and therefore based his new species upon a partial examination of mixtures.

His "*Schirmerite*" is evidently nothing else but a mixture of petzite, either with pyrite or perhaps with a telluride of iron—a mineral which has not yet been found in its *pure* state, the existence of which, however, is probable from the fact that both the true and the auriferous hessites, which are quite *free* from sulphur, invariably contain a minute quantity of iron—which according to my analyses varies from 0.15 to 1.35 per cent.

If Dr. Endlich had given his name to a good species, I would very cheerfully have adopted it and given another to my new sulphbismuthide of silver and lead—but as the mixture which he describes is not entitled to a name, that of "Schirmerite" must remain for my species.

His "*Henryite*" is undoubtedly nothing but an altaite, with an admixture of pyrite.

Knowing from Mr. Schirmer, that he has given me for this investigation the purest and best of *all* the minerals which have occurred at the Red Cloud Mine, I can state without hesitation that Dr. Endlich's species have no existence.

ON THE RESOURCES, PRODUCTIONS AND SOCIAL CONDITION OF EGYPT.

By Alexander Delmar,
Late Director of the United States Bureau of Statistics.

(*Read before the American Philosophical Society, October* 2, 1874.)

Introduction.

The United States of America produce annually about 275 million bushels of wheat, or about 6½ bushels per capita of population. Of this amount, they consume over 230 million bushels, or about 5½ bushels per capita; and have about 42 million bushels surplus left for sale.

The United Kingdom of Great Britain and Ireland produces annually about 95 million bushels of wheat and consumes 190 million bushels, or about 5¾ bushels per capita. It has therefore a deficit to purchase, amounting to as much, of wheat, as all it produces, or 95 million bushels. Thus, England has two bushels of wheat to buy where we have one to sell.

As wheat forms the daily bread of the two countries, and, unless in exceptional or extreme cases, no substitute for it will be accepted by the people, the purchases of these vast quantities of wheat on the one side, and their sale on the other, form, naturally enough, occasions for the exercise of a good deal of what may be euphemized as commercial diplomacy. In plain English the grain trade abounds with misrepresentation, and, as it happens, at the present time, this misrepresentation has, to a certain extent, centred itself upon the agricultural resources and wheat crop of Egypt.

Treating, as it will pretty fully, upon this topic, the present paper therefore claims to possess something more of scientific value than one which might have related less directly to the affairs of our everyday life; and although this claim might pass for nothing among peoples whose lives and thoughts are more in the remote past or remote future, than the present, I trust that it does not imply too great assurance if I venture to hope that, if made good, it will lose nothing at the hands of my own countrymen, on account of this utilitarian basis.

The gist of the present dispute about Egypt is as follows: A school of British agricultural writers at the head of whom is Mr. Kains-Jackson, estimates that during the ensuing harvest year 1874-5, the United Kingdom, instead of needing to purchase, as usual, about 95 million bushels of wheat, will require but 64 to 72 million bushels; and, on the other hand, instead of having to rely, as usual, mainly upon the United States, has by reason of the present year's abundant wheat harvest throughout the civilized world, the option of purchasing as much wheat—perhaps more—elsewhere, as she will need to purchase from us.

Among the countries specified by this authority, as having this year a surplus of wheat to dispose of, are France, Germany, Russia and Turkey.

Mr. Kains-Jackson's statements with regard to the wheat crops of all of these countries, as well with regard to that of his own country, have already been shown to be excessive; while as to Turkey, he was reminded that, so far from possessing a surplus crop of wheat, the people in Anatolia were dying from starvation, literally in myriads. To this, the response has been made that by Turkey was meant Egypt, and as none of the writers upon the subject appeared to know anything more about Egypt than that it was a land of pyramids, ruined temples and "backsheesh," Mr. Kains-Jackson has remained more or less unimpeached; and our manufacturers, our shipping and our railways, all of which, as things stand, depend largely upon the prospects of the grain trade, are thought to have indicated some symptoms of distrust with regard to the prospect before them for the coming year.

Should such distrust exist, I hope that it may tend at least in some degree to dispel it, if I here express the strong conviction that it is entirely groundless, and that during the ensuing harvest year, as hitherto, in the past, our surplus wheat will find as ample and profitable a foreign market—aye, in England, too,—as can be reasonably desired, and that, therefore, neither our domestic industries nor carrying trade, by land or water, should suffer anything from the misrepresentations that have been made.

And now to Egypt.

History.

Of the ancient history of this most interesting country, I need only say that it began in the remotest past and ended with the Persian conquest about 500 years before our era. About 200 years later, Egypt became a Greek province, under Alexander, and about 300 years later still, or at about the commencement of our era, it fell beneath the arms of Rome. This was the period, when, with reference to its function of supplying the markets of the city of Rome with corn, it was called the granary of the world. It was estimated by Greek and Roman writers to have contained at its most flourishing period a population of 7,000,000. With alternately Pagan and Christian rulers, as one or the other Roman faction succeeded in obtaining control of its government, Egypt remained in an anarchical state until the year A. D. 616, when the Persians again took it. They held it for ten years and surrendered it to the Arabs, who held it for 900 years.

At length, in 1517, it was conquered by the Turks, who—not without having for a time lost it to the Marmelukes, who in turn lost it to the French—have retained it to the present time.

Thus, from the most ancient period, Egypt has been an enslaved country—a fact whose reflection can be seen at all times in the extreme misery and abjection of her people. For the continuance of this wretchedness, England—but for whose interference forty years ago, the Pasha would have liberated his country from the Turkish yoke—is chiefly responsible. When that yoke is cast off and the Pasha, deprived of his

present excuse for the tremendous exactions he imposes upon the people, is rendered clearly responsible for their condition and welfare, Egypt may for once in almost countless years breathe the air of freedom. But until then it is impossible.

Napoleon reminded his soldiers that forty centuries of historic time looked down upon them from the pyramids. Let us, of England and America, whose heritage for over 600 years has been the largest freedom, and whose boasted mission it has been to place this priceless boon within the reach of all the men of earth, remember that from the appealing eyes of this unhappy people forty centuries of suffering look *up* to us.

After the departure of the French from Egypt, the Turks and Marmelukes were embroiled in civil war. This ended with the accession of Mehemet Ali, as Pasha, in 1805. In 1811 this usurper treacherously slew 500 of the Marmelukes and since that time Egypt has been in peace. In 1848, at the age of 80, Mehemet Ali became imbecile, and his eldest son Ibrahim reigned in his stead. Ibrahim died in two months and was succeeded by his brother Abbas, a profligate. Mehemet Ali died in 1849 and Abbas in 1854. To these succeeded the fourth son of Mehemet Ali, Said Pasha, who reigned until his death in 1863, when his nephew Ismail, the present ruler, ascended the throne. Ismail Pasha, granted the title of Khédive by an imperial firman dated 1867, is the son of Ibrahim Pasha. He was born in 1816; educated at the Paris Polytechnic School: speaks French and a little English; owns or manages everything in Egypt, among the rest, it is said, 27 palaces for his personal use; lives precisely the same despotic and luxurious life that his predecessors, the Pharaohs, did, thousands of years ago; like them he surrounds himself with foreign adventurers; like the Pharaohs, too, he builds the most astonishing and useless works of art; and like them crushes his unhappy people—the great bulk of whom are of the once warlike and progressive, but now despised Arab race—crushes them to earth with a disdainful and merciless scorn that finds its only fit expression in the bastinado and death.

Natural Resources.

Egypt has but a single natural resource—the Nile. There is no other river in the country; nor has this one a branch or affluent between its mouth and the Nubian desert. Beside the almost shelterless date-palms, there are no trees; the few wooded parks planted by order of Mehemet Ali, the ornamental trees of the cities, of which it is said Cairo and its suburbs contain 40,000, and the mulberry trees raised for silk worms—scarcely deserving to be mentioned in this connection. There is little or no rain; the agriculture of the country depending almost entirely upon the irrigating canals connected with the Nile.

Number of rainy days at Cairo from A. D. 1798 to 1800, about 15 a year; from 1835 to 1839 about 12; in 1871, 9. Quantity of rain in 1835,

17 millimetres; 1838, 11; 1839, 3; in 1871, not recorded, but the rain fell altogether only 9 hours during the year. Same climate throughout all Lower Egypt; while in Upper Egypt it is nearly the same.

There is no wood for fuel or building purposes, neither is there any coal. In day-time it is often bleak; at night-time chilly; though, for the most time the temperature is warm and sometimes uncomfortably hot.

Moneys, Weights and Measures.

1 para	equal	to	½ of 1 cent	U. S. gold.	
1 piastre	"	"	5 cents	" "	(*a*)
1 feddan	"	"	1.0323	acres.	(*b*)
1 ardeb, measure,	"	"	5.	bushels.	(*c*)
1 " weight,	"	"	270.	lbs. avoir.	
1 oke, oque, or occue	"	"	2.205	" "	(*d*)
1 cantar, cantaro or quintal	"	"	97.023	" "	(*e*)
1 kilometre carré	"	"	0.386	sq. miles.	
1 square mile	"	"	640.	acres.	

(*a*). The U. S. Treas. Reg. 1874, p. 486, fix the value of the Egyptian silver piece of 20 piastres at $1.0039. U. S. Consul Thayer (C. R. 1862, p. 582) says, 21½ piastres equal one dollar. The Treas. Monthly Stat. Mar. 1872, say that the Egyptian copper coinage has been recently much debased, but this does not necessarily affect the value of the silver or legal tender or "custom-house" piastre of Egypt. There was debasement of the inferior coins in 1837, also.—MacGreggor.

(*b*). The Alm. de Paris, 1869, says a feddan equals about 4200 mètres carrés. As a mètre carré equals 10.7064 square feet (Craig), 1 feddan equals 44,967 square feet; and as 43,560 square feet equal 1 acre, therefore 1 feddan equals 1.0323 acres. The U. S. Com. Rel. 1873, p. 1083, says a feddan is less than an acre. The M. S. 1872, say "about 1¼ acres." Buckle, Hist. Civ. (ed. Harper) v. 1, p. 61, says 1¾ acres, and Simmond's Com. Dic. says "about 1⅓ acres."

(*c*). The U. S. Com. Rel. 1859, p. 358, and 1873, p. 1083, and the general weight of authority. On the other hand, Buckle 1, 62, says it is less than 1-15th of a bushel; Kelly's Cambist says ⅛ to ⅓; Simmonds says ⅓ to 7¾ to 9¼, while the U. S. Com. Rel. 1871, p. 1107, say an ardeb is 15 bushels! The truth is it varies in all parts of Egypt. There are the Alexandria (used in the text on account of its greater universality), the Cairo, the Damietta, the Rosetta and many other ardebs. The Cairo ardeb is 1.821 hectolitres.—MacGreggor.

(*d*). U. S. Com. Rel. 1859, p. 358. But the C. R. of 1871, p. 1107, say 2.75 lbs., and Martin's Year Book and Kelly's Cambist say 2.832 lbs. It has not been used to obtain any of the numbers in the text.

(*e*). 1 cantar or cantal equals 44 okes or 100 "rottolis" or "rolls." Kelly's Cambist and the general weight of authority. But the Com. Rel. 1859, says 100 lbs.; Kelly says 95 lbs., which contradicts his previous statement, while other authorities say, variously, 97, 98¾, 112 lbs., and other equivalents.

TOTAL AREA OF EGYPT.

[Excluding the Soudan. (*f*)]

CITIES AND PROVINCES.	AREA—ACRES.	POPULATION. CENSUS MAR. 22, '71.
Cities of Alexandria, Rosetta, Damietta, Port Said and Suez, including 83,555 foreigners		654,569
Lower Egypt, including 4,483 foreigners	160,866,560	2,615,798
Middle Egypt		599,596
Upper Egypt		1,333,442
Nubia	230,440,960	3,238,595
Senaar and Meröe	130,692,480	
Massawa, Souakin and *Taka*, Provinces on the Red Sea, say	70,896,000	
Total	592,896,000	8,442,000

EGYPT PROPER.

Egypt proper consists of Lower, Middle and Upper Egypt. It contains 160,866,560 acres of area, and a population (in 1871) of 5,203,405. It is to this country only that the following statistics appertain, the outlying provinces and protectorates being omitted, as desert or savage countries.

ARABLE AREA.

The arable area of Egypt is confined substantially to the inundable portion of the valley of the Nile. As the river closely hugs the hills and palisades on its right bank, this area is nearly altogether on its left. In some places the arable lands are eleven miles wide; in others they dwindle to a mere strip of bank. For the most part, however, this area extends westward from the river about five to eight miles, where it is terminated by the Libyan hills and desert. Every year it is extended by the rise of the river upon its own bed. This rise was found to be, at the close of the last century, 4.960 inches per century. Some thirty years ago it was computed at 5.736 inches per century. From this source it is said that about 65,000 to 70,000 feddans of area are annually reclaimed from the desert (C. R. 1873, p. 1070); but, as will presently be shown, there may be as much or more lost from other causes; the area of cultivable land depending more upon social and industrial, than natural events.

(*f*). The *Soudan* Provinces include the Valley of the White Nile to the great N'Yanza Lakes and extend across the Continent of Africa westward from Nubia and south of Sahara. Their entire area is estimated at 1,600,000 square miles (about one-half the area of the United States), and it is said to contain 14 million feddans of land susceptible of cultivation (C. R. 1873, p. 1081), and a population of 60 millions, negroes. The south-eastern extremity of the Soudan was recently taken possession of by Sir Samuel Baker in the name of the Egyptian Government. It is accessible by small steamers from the lower Nile, and a railway is projected via Khartoum and Gondokoro.

In 1833, Egypt was estimated to possess 3,500,000 feddans of cultivable land, "if cultivation were pushed to its utmost extent."—MacGreggor.

The official survey of 1843 comprised 6,984,135 feddans susceptible of cultivation; but this included the superficial surface of the Nile and canals. The cultivated, and, doubtless, the cultivable, portion (at that time) consisted of 3,826,340 feddans as follows:

Provinces.	No of Feddans cultivated.	No. of Feddans uncultivated, including Surface of Nile and Canals.
Lower Egypt	2,749,106	1,551,011
Middle Egypt	750,409	843,608
Upper Egypt	826,825	763,176
Total	3,826,340	3,157,795

The report of 1843, and also a late report of the British Consul, are so worded as to convey the impression that there is almost as much cultivable land uncultivated as there is cultivated; but this is not the fact. The so-called cultivable land, not cultivated, consists, and has always consisted, for the most part either of the surfaces of the Nile and the canals, or of lands in the Delta and elsewhere, which from various causes have become barren or unavailable.

"A perpetual struggle is carried on between the desert and cultivation. In many parts of the Delta the desert has invaded and mastered the soil."—MacGreggor, 1833.

"In the Faioum, which was formerly the most richly cultivated part of Egypt, the desert has made many inroads."—*Ibid.*

"In * * * places on the western border of the Nile Valley, the shifting sands of the desert have encroached on the domain of cultivation."—Com. Rel., 1863, p. 532.

"When the land, as has happened in Lower Egypt and the Delta, from the despotic appropriation and thriftless husbandry of * * * rulers, has become what is called *aladish*, and gone to waste, light plows (such as are used here) are powerless to improve it. Villages, for example, often deprived of laborers to furnish recruits for foreign wars, were at one time depopulated by the government, and their lands exploited (used up) by a short-sighted and ruinous system of agriculture, from the effects of which the country still suffers. In order to have an uninterrupted succession of crops, the inundation (of the Nile) was excluded by dykes, irrigation being supplied from the brackish water of wells. The deposit of salt after evaporation, added to that which would be pushed to the surface by the upward filtration of the Nile, would soon convert a once fruitful tract into a desert, where nothing would grow but a rank crop of 'halfa,' a deep-rooted, tough grass, which, with the ordinary farming implements of Egypt, it is almost impossible to extirpate. It has thus

been considered an unprofitable undertaking to attempt to improve these barren lands, raised, as they frequently are, by the deposits left by former growths of this pestilent grass above the level of inundation, and from this cause *one-half of the Delta is said to be uncultivated.*"—*Ibid.*

This alone would dispose of some two millions of acres.

"Part of the (barren) territory (now being reclaimed by the Suez Canal Company) was known in ancient times as the fruitful land of Goshen."—*Ibid.*

"A large part of the land formerly cultivated in Egypt is to-day sterile."—*Ibid.*

"In the present cotton region the land has become so poor that now only two cantars a feddan are produced where five used to be gathered. * * * There is plenty of land; it only wants moisture to make it fertile; and we would like to see a number of irrigating canals," etc.—C. R., 1866, p. 435.

The accounts are the same to the present day.

The following table shows the cultivated area at several dates, from 1812 to 1874 inclusive:

COMPARATIVE STATISTICS OF CULTIVATED AREA IN EGYPT.

YEAR.	FEDDANS.	ACRES.
1812	3,218,736	3,322,701
1833	1,856,000	1,915,950
1835	2,000,000	2,064,600
1843	3,826,340	3,949,931
1868	4,296,736	4,435,521
1873	4,624,221	4,773,583
1874	4,625,000	4,774,388

This table shows, that from the time of the accession of Mehemet Ali, to the close of the war in Syria, the cultivated area in Egypt rapidly declined. It then suddenly increased until, in 1843, it attained its former extent again. From that time to this it has slowly increased. The causes of this extraorinary movement will appear when the progress of the population has been examined.

POPULATION OF ALL EGYPT.

(Excluding the Soudan.)

YEAR.	ESTIMATED POPULATION.	AUTHORITY.
1862	7,465,000	Dr. Schnepp.
1871	8,442,000	Dr. Wagner.

The Almanac de Gotha for 1873 gives the population, at a recent date, at 8,000,000, and appears to quote Mr. E. de Regny, the official statistician of Egypt, for authority.

POPULATION OF EGYPT PROPER.

YEAR.	POPULATION.	AUTHORITY.
1812	3,000,000	Estimate.
1820	2,500,000	Morse's Gazetteer.
1833	2,000,000	MacGreggor.
1844	3,350,000	Alm. de Gotha.
1847	4,542,620	Census.
1859	5,125,000	Census.
1863	4,709,116	Com. Rel., 1873.
1866	4,848,528	Br. Con. Ret., 6–1867.
1867	4,888,925	Com. Rel., 1873.
1872	5,203,405	" " "
1873	5,250,000	" " "

This table exhibits a decrease of population from the time of Mehemet Ali's accession, to the close of the Syrian war, similar to that shown with regard to acres of cultivated area. It likewise shows the same sudden growth immediately afterward, and even a slower growth since. These coincidences are undoubtedly due to the same causes—the wars of Mehemet Ali, particularly those in Syria; the abandonment of the country for the desert, in preference to participation in those wars; and the subsequent return of the people from the battle-fields and the wilderness. Says MacGreggor, "Almost without exception the laborers mutilated themselves by cutting off the first finger of the right hand, destroying the right eye, or pulling out the front teeth, in order to avoid the conscription," p. 231.

COMPARISON OF POPULATION AND CULTIVATED AREA.

If the large estates worked by the Khédive and his relatives, or the nobles of his court, be deducted, there will not remain in Egypt over one-half an acre of arable land to each person; and even if the land cultivated at present were divided equally among all, there would still be not over nine-tenths of an acre per capita. To show how comparatively small an area this is, I give the statistics on this point relative to the countries with which we are most familiar.

RELATION OF CULTIVATED LANDS TO POPULATION IN FOUR DIFFERENT COUNTRIES.

Country.	Year.	Cultivated Lands. Acres per Capita.		Cultivated Lands, including pasture and forest lands in use. Acres per capita.	
United States (*g*).....	1850	4.9	Average, 3.3	12.7	Average, 6.5
	1860	5.2		13 0	
	1870 (*h*)	4.9 (*h*)		10.6 (*h*)	
United Kingdom.....	1873	1.4		1.5	
France.....	1872	2.2		3.1	
Egypt.....	1873	0.9		0.9	

The United States is an agricultural country, which furnishes other countries with breadstuffs out of its own surplus. The United Kingdom is a manufacturing country, which has abandoned the policy of attempting to raise its own breadstuffs, and relies largely upon foreign supplies. The quantities of the latter—that is to say, all breadstuffs (not wheat alone)—usually exported by the United States, do not materially exceed those usually imported by the United Kingdom; hence an average of the amount of cultivated land per capita in the two countries shows very correctly the true amount needed to support each head of population. According to the table above, this average is over 6½ acres. In France, which imports breadstuffs as often as it exports them, and whose population and means of subsistence are running a close race, the average number of acres to each head of population is over three. Imagine how small, then, must be the portion of an Egyptian laborer, who, if even he had a fair share of all the cultivated land in his country, which is far from being the fact—who, if that land were as productively tilled as are the lands of the other countries named, which, as will be presently shown, is not the case, and who, if all the food-products of that land were kept at home instead of being shipped abroad, as a large portion of them are, would still possess but one-seventh the heritage of an American or Englishman, and but one-fourth that of a Frenchman.

RURAL AND CIVIC POPULATION.

There are few towns in Egypt beside those already specified. Among them is Syout, with a population estimated in 1874 at 25,000 (Contemp. Rev., Feb. 1874.) The total civic population of Egypt is estimated at

(*g*) The lands classified in the United States census as "improved farm lands," are treated above as "cultivated lands," and the "unimproved farm lands" as "pasture and forest lands in use," as adjuncts to agriculture. "No farm of less than three acres, not unless $500 worth of produce has been sold off it during the year," is included in the United States census returns—a very absurd and misleading exception.

(*h*) The United States census of 1870 was the worst ever taken, and is palpably deficient in almost every respect. The census of 1860 is much more complete and reliable.

700,000, or 13 per cent. of the whole, leaving the rural population to consist of 4,503,405, or 87 per cent. of the whole.

Occupations.

There are no manufactures in Egypt except those owned and managed by "the government," or, in other words, Ismail, son of Ibrahim. The principal ones are the two cotton cloth factories which supply the coarse white cotton clothing used by the soldiers, and the blue stuff of cotton and wool worn by the peasant women. One of these is at Boulac, the other at Choubra, near Cairo. Together they employ 1,438 workmen, and produce annually $122,970 worth of cloth and $13,740 worth of linen —an average of $95 per workman. There is a manufactory of tarbooches (these are the national cap) and carpets at Fueh; a printing establishment at Boulac for Turkish and Arabian works, which employs about 150 workmen; a paper-mill at Boulac, which employs 50 workmen, and produces annually 350 cantars of wrapping, and 66,500 reams of printing, writing and colored papers; two gunpowder-mills worked by mule-power, near Cairo; several large bakeries at Cairo, which together consume about 800,000 barrels of flour per annum; and some other small works.

These, with the salt-works monopoly, which turns out some 360,000 bushels of salt per annum; the fisheries, which employ 3,760 persons on salt, and about 6,000 on fresh, water; seventeen short railways and branches; the telegraphs, the Nile steamboats, and a few navigable canals, are all the industrial works in Egypt, unless the manufacture of native sugar and ginning of native cotton are included in the same category. They are all owned and managed by the Khédive, who, by thus engrossing all the branches of trade, effectually crushes native, and shuts out foreign, capital and enterprise. Mehemet Ali made strenuous efforts to become a cotton manufacturer, and at one time had 44 factories and 20,000 operatives, consuming annually 30,000 cantars of cotton, at work; but the enterprise was abandoned.

A considerable portion of the persons employed in the present industrial works in Egypt are foreigners; even the fisheries, employing many Maltese, Greeks and Italians. The number of those employed in agriculture, including their families, is estimated at 4,400,000, or about 85 per cent. of the whole population—a number and proportion nearly identical with those of the entire rural population.

Size of Farms.

The Viceroy, or Khédive, and his family cultivate one-fourth of all the arable land. A farm of the late El Hami Pasha consisted of 39,368 acres, of which 13,344 were let. There are other large estates. The holdings among the fellahdeen, or peasantry, range from one-eighth of an acre to one acre in size.

Land Tenures.

Theoretically, all lands were held of God by the Sultan of Turkey. In Egypt the Viceroy stood in place of the Sultan, and had power to grant

tenancies in fee, estates for life or a term of years, metayerships and other tenures, except to the mosques, which held directly from the Sultan.

But Mehemet Ali simplified all this by seizing the lands of the mosques, confiscating all the private titles, and appropriating the entire land and its people to his own use. Certain nobles and foreign adventurers have since been allowed to obtain doubtful tenures of the land, the basis of which is, however, in all cases, the Khédive's will. The portions not managed directly by the latter and his beneficiaries are cultivated by the wretched fellahdeen, and held, properly speaking, by no tenure except that which naturally attaches itself to compulsory service.

The Turkish laws of succession, designed by Mahmoud II. and Abd-el-Mejeed to put an end to the great feudatories which existed in their days, imperatively command equal subdivision of land among the heirs of the first degree in descending or ascending line, male and female alike; failing these, in collateral line, etc. Entails were abolished; transfers of real estate were to be made by entry at a public registry, and the transaction heavily taxed; private deeds between the parties were not to be recognized. How far these regulations have been applied in Egypt it would be difficult to say.

System of Culture.

The system of culture hardly deserves the name, and simply consists of waiting upon the annual overflow of the Nile to fill the irrigating canals, and when the river has subsided, of maintaining the level of the canals and reservoirs by pumping, baling and ladling. This last-named work and "the digging of fresh canals engross the labor of the people for months," writes the British consul, Mr. Stanley, in 1873. Without this incessant struggle with nature, the lands would become uncultivable, and even with it the result is doubtful; for if the next overflow of the river exceeds thirty feet in height, everything on the land is demolished and swept away; while if it falls short of eighteen feet, the harvests fail and famine ensues. Of the 66 inundations between 1735 and 1801, 11, or 17 per cent., were high and devastating; 16, or 24 per cent., were feeble; 9, or 14 per cent., were insufficient; and only 30, or 45 per cent., were good. The chances, then, appear to be about even, as to whether, after all his labor, the Egyptian gets a harvest or not. Such a system does not admit of fallows, rotation or manuring. The irrigating canals or reservoirs of the large estates are supplied with water from the river by steam power, the coal being imported from England; but for the most part this work, and the digging and dredging of the canals, ditches and reservoirs, are done by hand, and with the rudest implements.

Sometimes two, three and even four *shadoufs* or baling machines are placed close to each other and employed to raise the water by the pitcherful at a time, to as many reservoirs at different elevations, until it reaches the highest. Each *shadouf* requires two men to work it. "During many months of the year the whole Arab population appears to be engaged in bringing water from the Nile to the adjacent fields."—MacGreggor.

The total number and kinds of machines now in use for the purpose of irrigation will be shown further on.

The Nile usually rises late in May. In August it reaches such a height that the canals are opened, the entire valley is soaked and the reservoirs are filled with water. It continues to rise until October, and then falls so rapidly that, in some parts, pumping and baling commence in November or December; though, in others, not until February, when they continue until May or June.

Fertilizers.

As a general thing no fertilizers are employed; the deposits of mud left by the river during its overflow being the main dependence of the husbandman in this respect. An analysis of this mud gives the following results: silica 53.04; sesquioxide of iron 18.43; sesquioxide of alumina 8.76; carbonate of lime 4.19; sulphate of lime 0.75; lime 2.25; magnesia 0.66; potassa 0.69; soda 2.16; chloride of sodium 0.04; organic matter 9.03; total 100 per cent. Owing to the extreme scarcity of trees and entire absence of coal, fuel, for all purposes, is exceedingly dear. For this reason animal manure, and during the cotton excitement 1862–1867, even cotton-seed, the price of which had at former periods exceeded that of wheat, were used for fuel; and the former continues to be thus employed yet. Cotton-seed, however, degenerates so rapidly in Egypt that, except for this purpose, or the superior ones of extracting oil from it or using it for cattle fodder, it possesses little value there, unless it is freshly imported from other countries. The Khédive has promised a large pecuniary reward and the title of Bey to whomsoever shall discover paying deposits of *coal* in Egypt.

On the sugar estates the culture exhausts the earth so rapidly that pigeon-guano is largely used to enrich it; about half a ton being employed to the acre of land. In order to obtain this fertilizer the keeping of a flock of pigeons is part of the fellah's duties to the state. The birds are simply provided with the shelter of a mud-cote and left at liberty to provide their own sustenance. This, of course, is derived, one way or another, from the fellah's corn-field, and in this way the birds constitute an additional agency of taxation upon the wretched peasant. About 267,000 tons of this guano are now annually produced in Egypt.

In justice to the Egyptian system of agriculture, it should be stated that there *is* a certain rotation of crops observed, but unlike any other system known, except that of the despotic President Lopez, who runs a government in South America which is somewhat ironically styled the "republic" of Paraguay, the order of that rotation is governed altogether by the will or caprice of the Khédive. Rice and maize used to be largely cultivated in Egypt; but the government ordered wheat to be planted in their stead and the latter became the principal exporting crop. It was grown one year after another, until nature gave out and the grain grew so poor that it could scarcely find a market. That exported to England

was used only in the distilleries. The American war occurring at this juncture, the government prohibited the cultivation of wheat and nominated cotton in its place. The culture of this staple was pursued until the fall of prices occurred after the war, when it was superseded in turn by sugar, which is the present favorite. The exports from Alexandria, the shipping port of the country, which will be given further on, will furnish a close guide to the fluctuations in the product of these articles, occasioned by this capricious, ruinous, and sometimes mortal policy.

Seeding.

The seed is thrown broadcast, the use of the drill being wholly unknown. About 3½ bushels of wheat are sown to the acre, the produce being 11¼ bushels, or scarcely more than 3 for 1. Even ploughing was formerly dispensed with in many parts, the seed being thrown upon the mud left by the receding river, and domestic animals turned loose to trample in the grain. This and other wretched features of Egyptian agriculture are giving way before better methods. The cotton and sugar-cane which now constitute the chief products of the country, are cultivated mainly by the large proprietors and sown, or planted, as in the United States.

Domestic Animals.

Previous to the cattle disease in 1863 and 1864 which destroyed in a single year 800,000 head of horned cattle, and, in Lower Egypt, nearly every other animal also, and which, together with the cotton mania of that period, contributed to occasion the famine of 1865, the number of domestic animals must have exceeded one million. At the present time it barely amounts to two-thirds of that number, as follows :

Horned cattle (including buffaloes, the main dependence of the peasant for the work of the farm)	292,100
Horses	18,203
Mules	2,105
Asses	94,641
Camels	35,578
Sheep	172,657
Goats	23,907
Total	639,191

These numbers do not include the animals in Alexandria and Cairo. During the year 1872 there were imported at Alexandria 14,185 head of cattle and 200,087 sheep, chiefly for slaughter.

In 1871 the average prices of 71,400 animals sold at the fairs of Tantah in the Delta, were reported by the American consul as follows : Cattle $200 each ; buffaloes $175 ; camels $200 ; horses $100 ; asses $25 ; and sheep $6.25. (Doubtful.)

Wages.

In common with many European and all Oriental countries, women in Egypt are employed in field labor. The following were the prices of labor current at four different epochs. Men's wages per diem are always meant unless otherwise specified.

Year 1837.

Field laborers	Lower Egypt	$0.02½ @ .05
	Upper "	.02½ @ .02¾
Boys and girls, sugar plantation		.01¼ @ .03

Year 1841.

Laborers, at Cairo, average	.05
Keepers, or gang-leaders	.10

Year 1863.

Night operative in cotton-gin at Mansurah	.24½
Day operative, same work, boy or girl	.12
Laborer on Suez Canal	.20

This was the period of the cotton mania. The American consul, writing at the time, said, "within a year wages have been doubled."

In 1865 the American consul reported that there had been an important rise in wages in late years, mainly due to the redundance of specie caused by the high prices at which cotton sold.

In 1867 the British consul reported that "wages and land had quadrupled."

Between this period and 1873 there seems to have been a fall in wages.

Year 1873.

Field laborers	Lower Egypt,	.15
	Middle "	.10
	Upper "	.07
Unskilled operatives in factories and at salt works, according to age and ability, 15c. @ 40c. per diem, average		22½
Mechanics, such as masons, carpenters, blacksmiths, etc., without board or ration		.60 @ 1.00

The American consul reported in 1873 that wages appear to have declined since the cotton mania, but that they are said to be now rising again.

Efficiency of Labor.

An Egyptian laborer is considered to have done a good day's work when he picks 15 to 18 pounds of cotton. The American negro slaves usually picked 50 pounds in the same time. An Egyptian with the aid of a *shadouf* (pole and jar, or bucket) can raise for irrigating purposes an average of about seven gallons of water per minute; an American with an improved hand pump can raise 100 gallons per minute, or 14 times as much. The constant use of the stick and bastinado is necessary to keep at work the fellahdeen on the Khédive's estates (C. R. 1871). This fact

may, however, be due to other reasons than mere physical infirmity. The immediate labor of about 15 persons out of every 100 in the United States produces more than enough food for all; whereas in Egypt the same result calls for the immediate labor of at least three times as many persons; while the result itself is greatly inferior in quantity, quality and variety.

That this great comparative inefficiency of Egyptian labor is due less to natural inaptitude than to poor food, rude implements and other circumstances over which he has no control, is manifest from the recorded observations of very intelligent persons.

Says MacGreggor, writing of Egypt, "The Arabs, if brought young to the cotton factories are of quick intellect and easily learn any branch of the trade." * * * "They show considerable dexterity."

Says Dr. Rüppel: "The young Egyptians show great skill and often surpass their masters in cleverness."

Taxation.

The tax system of Egypt is contrived to keep its unhappy people precisely at the point where it is a matter of the utmost unconcern to them whether they live or die. It is impossible to ascertain what this burden amounts to in money, but substantially, it deprives the population of all the fruits of their industry, leaving them but a bare and most wretched subsistence, without lands, homes, clothing, security, justice, or education—and, but for dates and dourra, even without food. The peasant's home is far less comfortable than that of some wild animals—for instance, the beaver. It is of the same character as the latter—a mud hut—and teems with vermin. Great numbers of the people live in the ancient tombs, with darkness and the bats.—Stephens' Travels 1837. The dress of the people hereabouts (at the First Cataract, the confines of Egypt proper and Nubia) consists of a piece of leather about six inches wide, cut in strings and tied about their loins. I bought one from a young girl of 16, whose sweet mild face and exquisitely charming figure the finest lady might have envied.—*Ibid.*

Men are seized in the streets, the bazaars, anywhere, "the iron bands put around their wrists, the iron collars around their necks," and forced to work for the Pasha.—*Ibid.*

"People are taken away in gangs from their own ground to do work for powerful land-owners, which in no wise benefits their districts."—British Consul Stanley, 1873. "A man was convicted of stealing an amber mouth-piece from Abbas Agga. His punishment was to be bound to a cannon and blown to atoms. The same official pressed 600 fellahs into his service to dig him a canal; made them work 12 hours a day; lashed them unmercifully, and did not pay them a single para."—Dr. Holroyd's Travels, 1837. The Koran is the only book in the land and that it is considered sacrilegious to print. Those few who can read and write are called fickees or saints.—*Ibid.* The people are strictly temperate, exceedingly docile and naturally intelligent.

In 1837 the *miri* or land tax was from $1.75 per feddan per annum on ordinary lands, to $5 on sugar lands. It is at present, 1874, about $5 per feddan on all lands. Beside this, there is a poll tax; a tax on date trees, which, as elsewhere explained, is equivalent to an additional poll tax; octroi taxes on the principal articles of consumption; tolls to support the irrigation canals; taxes on the fisheries (one-third); on salt; on the consumption of wheat ($1) and barley, beans, Indian corn, and pulse (75 cents per bushel in 1837); import and export duties; monopolization of all the branches of industry by the government; forced service; debasement of the copper coinage and every other device of a vicious and merciless finance. Beside these, there are dues to the mosques and various local exactions.

The total revenues of the Viceroyalty in 1821 were about $6,000,000; in 1833 about $12,500,000; in 1850 about $20,000,000; in 1872 about $36,500,000. This last sum is equivalent to 10 cents per day for every family in the country, or the whole value of the labor of every father, or head of family. The same rate of taxation—that is, the whole value of one man's labor exacted from each family in the land—were it possible in the United States, would amount to 8,000 million dollars per annum, or four times the whole sum of the national debt. But thank God, it *isn't* possible.

The taxes are raised in Egypt through a *Sheik-el-belled* or head of village commune, chosen by the people and against his will, for although armed with arbitrary power, should he fail to collect the heavy tribute, his life is generally forfeited. The government sends him in chains to the Southern frontier and he is seldom heard of again.

Interest.

The Mahometan law, like the canon law of Christianity and the ancient Jewish law, forbids the taking of interest; but like those laws, it has fallen into disuse in this respect. In 1837 the Viceroy allowed 6 per cent. for advances to him from European houses.—MacGreggor. At the same time the market rate for money among mercantile houses in Egypt was 10 to 18 per cent. per annum. At the present time the rate of interest ranges between 10 per cent. on the most desirable class of government securities, to 60 and even 100 per cent. per annum on fair commercial risks. These excessive rates appear to result less from high profits than great insecurity and the lack of a basis of individual right for an administration of justice. The prevailing insecurity is susceptible of being illustrated by four striking examples. 1st. The tenure of lands is merely the will of the Viceroy. 2d. In 1866 the Viceroy informed the European resident creditors of the rural population that, in future, it would be useless for them to claim against the natives.—Br. Cons. Rep. 6–1867, p. 296. 3d. In 1864, though gold was at that time pouring into the country to pay for cotton, so overwhelming was the general instinct to hoard and bury money, that little or none of it remained in circulation. "On one

occasion, when the French packet from Marseilles arrived in the afternoon with seven millions of francs in specie, I was informed by the agent of the company, the same evening, that he had reason to believe that not a single coin of the whole amount had remained in Alexandria. It had been taken to the villages where it is generally buried in the earth."—Com. Rel. 1865, p. 484. 4th. The monopolies. In 1864, during the high price of cotton, the Viceroy refused permission for the cotton of other cultivators to be brought to market until his own was first shipped.—*Ibid.* In 1865 and 1866, though there was a famine in Egypt, corn fetched a higher price at Jidda, in the Hedjaz, a province of Arabia on the Eastern coast of the Red Sea. The merchants, who hastened to ship corn to Jidda, were stopped by the Viceroy; who, disregarding the famished condition of his own people, hastened to sell his corn to the Arabians and obtain the higher prices which necessity compelled them to offer.—Br. C. R. 6–1867, p. 134.

The following quotations exhibit the rates of interest current in Egypt of late years.

1863. Three to five, and even seven, per cent. a month was paid by fellahs to the Levantine traders who lent them money wherewith to pay their taxes. Same year, five to ten per cent. a month was paid on good security.—C. R., 1863.

1864. "Minimum rate, ten per cent. per annum. Two and three per cent. a month often paid by parties of the first position for temporary loans."—C. R., 1864 and 1865.

1872. Seven to ten per cent. per annum on government securities.—M. S., 1872.

Agricultural Implements.

On the estates of the Khédive and other large planters, modern implements are in use; but the natives appear to be so ill-fed as to lack the physical strength and skill to wield them. Hence their reluctance to work on these estates, and the cruel practice of forcing them by blows; for, as things go, the Khédive pays them well. (C. R., 1871.) In 1862–3 the Khédive employed steam irrigating machinery in Upper Egypt. At the same time there were in operation eighty steam cotton-gins; steam pumps were used by other large proprietors, and steam plows were tried on the barren "halfa" lands of the Delta. (C. R., 1863.) Since that time, other improved implements have come into use on the same class of estates; but the peasants continue to employ the antique and inefficient implements common to the Orient from the most ancient times, the causes for this preference being poverty, physical infirmity and, above all, political insecurity. These implements consist of the plow, which is merely a crooked stick, sometimes barbed with iron; the mattock, the hoe, the spade, the *dulab* or hand-gin for cotton, and the *sakye* or *sakia*, the *chadouf* or *shadouf*, and the *tabout*, for irrigating purposes. The *sakye* is a horizontal wooden cog-wheel, turned by oxen and working into the perimeter of a vertical wooden cog-wheel, which, in revolving, elevates

an endless rope chain, to which are attached earthen jars. Filling with water at the bottom of the well or shaft, these jars empty themselves at the top as they begin to descend.

The *shadouf* is an upright forked pole in which turns a beam with a bucket or jar at one end and a lump of mud to balance it at the other.

The *tabout* is a basket, to be handled by two men, and only used when the water is to be raised but a few feet. The number of the various implements used for irrigating purposes in 1873 was as follows:

Steam-pumps	476
Sakyes (*i*)	30,084
Shadoufs	70,508
Tabouts	6,926
	107,994

Chief Articles of National Diet.

Dates and dourra constitute the chief dietary of Egypt. It is a remarkable fact that the number of date-trees under cultivation has generally coincided with the number of inhabitants and the number of acres of cultivated lands. The causes of this correspondence with reference to the number of date-trees are doubtless the coincidence of their period of bearing with the ordinary duration of a man's life, and their yield of fruit with the capacity of man to consume it, which for each tree and each man is alike one pound a day. These circumstances combine to render the tax, (now yielding about $700,000 per annum) which is placed upon date-trees, really a tax on polls, of both sexes and all ages, amounting to about 14 cents per capita.

There are now about 5 million date-palm trees in Egypt. The trees are raised by shoots, arrive at their vigor in about 30 years, and continue so for seventy years afterward, bearing yearly fifteen or twenty clusters of dates, each of them weighing fifteen or twenty pounds. After this period they begin to decline. Upwards of 200 trees are sometimes planted on a single acre (Buckle, 1, 61). Wilkinson, from whom Buckle quoted, said 400 to a feddan. Accepting the lower number as nearer the truth, it would follow that 25,000 acres of land are devoted to the growth of date-palms in Egypt. The average annual yield in 1873 was four cantars of dates to each tree (C. R,, 1873, p. 1086). This would make the aggregate yield about 20 million cantars. All but 30 thousand cantars, or one-sixth of one per cent., which is the amount annually exported, are consumed in the country. Dates are not used for human food alone, but

(*i*) The number of *sakyes* in use in 1838 was estimated at 50,000, costing 3¼ million dollars a year to work them, the power employed on each machine being that of two cattle and one man (C. R., 1833, p. 533). In 1837, for want of pruning-hooks or knives, the fellahdeen engaged in cultivating cotton in Upper Egypt, broke off the branches instead of cutting them; while for want of a press, the bale of cotton was packed with the foot (MacGreggor). The absence of so common an instrument as a knife is due to the fact that the government prohibits the bearing of arms by the populace. The prudence of this precaution is evidenced by the following extract from Stephens: "Speaking of the general poverty of the Arabs, the Sheik said that if one-fourth of them owned a musket, one charge of powder and one ball, before morning there would not be a Turk in Egypt."

are also fed to horses, asses, camels, sheep, fowls and dogs, the animals consuming all the abortive fruit, and even the date-stones, when softened in water and ground up, the latter being often collected for the purpose by indigent persons. The young shoots of the date-palms are used as a delicate vegetable, resembling asparagus; the leaves afford couches, baskets, bags, mats, brushes, etc.; the trunk affords wood for fences, fuel, etc.; the fibrous part, cordage and thread; the pith, starch; and the sap, a fermented liquor.

Dourra (*j*), indian-corn, blé turc, millet, sorghum (*S. vulgare*), or Guinea corn—for it is known by all these names—is a species of *holcus* (allied to broom-corn, etc.), and the principal grain of Egypt next after wheat. Varieties of this grain are grown in Africa and Asia, and it has been tried in Pennsylvania, Massachusetts, California and elsewhere in the United States, for use as cattle-fodder, but abandoned (except in California, where its cultivation was only begun a few years ago) in favor of oats or barley. Next to dates, it forms the staple food of the Egyptian peasant, and in Upper Egypt and Nubia particularly. Indeed, in Nubia it is used for the purposes of currency. Wishing to prove the prolificacy of dourra, and quoting Hamilton's *Egyptiacæ*, Buckle says (vol. 1, p. 62) that "it yields to the laborer a return of 240 for 1." It is possible that a single grain will yield a plant bearing 240 grains; but this degree of prolificacy is exceeded by maize and many other cereals. Therefore, taken by itself, this fact means nothing. But if Hamilton meant that the average yield of large areas sown in dourra is 240 for 1, which is what Buckle took it to mean, this statement is as wild as his other, that an ardeb is 16 bushels. Nor does it signify, in this connection, that, to quote another author (Appleton's Encyc. Art. *Millet*) a bushel of millet has been grown on six square rods of land, which is equal to 26⅔ bushels to the acre. The practical fact is, that in Egypt, at the present time, dourra yields on the average about 12 bushels to the acre (the C. R., 1873, p. 1085, say 2¼ ardebs per feddan), or somewhat more than wheat in the same country. Its preference to the latter is doubtless due either to the lesser amount of seed and care required in its cultivation, or to the lesser trouble required in its preparation for use. It is ground between two stones and made into a brown bread, said by an enthusiastic traveler to be of "admirable quality" (Contemp. Rev., Feb. 1874), but is greatly deficient in flesh-forming materials. Hamilton says, that "in Upper Egypt the dourra constitutes almost the whole subsistence of the peasantry;" but this is so far from being correct, that they eat several pounds of dates to one of dourra. Although its use in Egypt is less common as one proceeds from Nubia to the Delta, it is nevertheless still largely consumed in Middle Egypt. The lotus, which was used for food in the time of Herodotus, is now almost a rare plant.

Beside dates and dourra-bread, the food of the Egyptian peasants consists largely of beans and lentils, which are made into soups and other

(*j*). Spelled variously, as dourra, dourrah, dhourra, dhurra, dourah, dowrah and durr

dishes. A very little fish is obtained, but no meat, except on rare occasions, when a sheep is slaughtered and consumed, even to the entrails. The total cost of an adult peasant's subsistence in 1837 ranged from 1 to 2½ cents per day. It is now, 1874, 3½ to 7½ cents. So effectually does the government deprive the people of the means of subsistence, that says MacGreggor: "If the poor fellah does not secrete some of his produce, it sometimes happens that *nothing* is left him at the conclusion of autumn to maintain himself and family through the winter."

Navigable Rivers.

The Nile is navigable by light draught boats from its mouths to the rapids or cataracts, about 600 miles above. The draught of water in the Rosetta mouth is five feet, and in the Damietta, eight feet, at low tide. During the inundation, the draught is often forty feet, and large vessels can ascend to Cairo.

Navigable Canals.	Miles long.
Mahmoudy, Lower Egypt	50
Ismaïlia, " "	61
Beherah, " "	30
Ibrahimieh, Upper "	93

Beside these, there is the Suez International Ship Canal, 69 miles long; the Bahr Yusuf, or ancient irrigating river of Joseph, some 300 miles long; and hundreds of irrigating canals, many of them of great size, not to count innumerable runnels and ditches, for the purposes of irrigation.

Railways.

The following table shows the progress that has been made in railways in Egypt:

Year.	Miles.
1863	245
1871	654
1873	736½

In 1873 there were completed twenty-one railways, aggregating 736½ miles, of which about 200 miles were double track; also, in progress, 208 miles and a single railway of 600 miles to the Soudan.

But with all this progress, says British Consul West, in 1867, "the trade of Suez is on a most limited scale, and is almost exclusively confined to the supply of the daily wants of its few inhabitants. The imports from the Red sea or from India are all on account of the Cairo merchants, and the goods are received here by native wakeels, or agents, simply as forwarding agents. The duty is paid on them, and notwithstanding the line of railway between Cairo and Suez, they are transmitted not unfrequently on camels!"

The Consul explains that there are several reasons for this singular preference, neither one of which is creditable to the existing government, which not only lords itself despotically over the people, but owns, monopolizes and administers the railways.

First. "The natives avoid coming into contact with the government officials," who manage the railways.

Secondly. "Time is of but little object, and the saving of it, *if any, by rail*, is questionable, owing to the delays in forwarding and obtaining delivery of the goods."

Thirdly. "The rates of railway freights are so high as to make but little, if any, difference in the cost."

Though it should be remembered, in mitigation of this charge, that all of the materials, some of the *personnel*, and, most important, all of the coal for the railway service has to be imported from Europe; yet the Consul's reasons for the avoidance of the railways involve reproaches to the Khédive's system of rule, which appear to show that even with cheap fuel, railways and despotism will not work well together.

The converse of this induction, that railways need a free government for their development, is strikingly shown in the great progress which the former have made in this country, and the relative progress they have made in all countries.

When it is remembered that thousands of years ago Egypt possessed stone railways, and perhaps also wooden ones, it is rather a dark stigma on the Khédive's rule that, with all his efforts to imitate European progress, the government he has established is so distasteful to his people, that rather than employ his boasted engines of progress, they find it preferable to return to the camels and the old paces and slow ways of their forefathers.

Of telegraphs there were in 1863 about 360 miles, and in 1873 about 3,460 miles. These works all belong to the government.

Rates of Freight.

In 1863 the freight on baled cotton by railway from Mansurah to Alexandria, a distance of about 100 miles, was 48 cents per cantar, or, say, 55 cents per cwt. Rates of freight from Alexandria to Liverpool in 1873, for wheat and beans 61 cents @ $1.34 per quarter of 8 bushels; to Marseilles, 60 cents per 100 kilos., or, say, 17 cents per bushel.

Having now very fully examined Egypt's resources, natural, artificial and human, we turn to the practical results of these means and forces, which are summed up in her

Agricultural Products.

In 1834 the produce of Egypt was stated to Dr. Bowring as follows:

Wheat, bushels	3,144,500	Sugar, cwts	32,000
Beans, "	2,648,000	Cotton, "	206,000
Lentils, "	231,700	Flax, "	55,000
Barley, "	1,853,600	Saffron, "	3,500
Maize, "	529,600	Tobacco, "	100,000
Dourra, "	2,813,500	Hennah, "	30,000
Chick peas, "	165,500	Indigo, lbs	212,575
Lupins "	115,850	Silk, "	178,750
Helbeh (*k*) "	364,100	Opium, "	41,250
Rice "	450,160	Linseed, bushels	198,600

(*k*) A seed with a somewhat bitter taste, whose flour is mixed with dourra.

The quantities in the above table are obtained by reckoning 3.31 Cairo ardebs to the bushel and $2\frac{3}{4}$ pounds to the oke. The cwts. are as stated in the original.

In 1873 the products, feddans cultivated, average yield per feddan and total yield were as follows:

Products.	No. of Feddans Cultivated.	Av. yield per Feddan.	Aggregate yield.
Cotton, cantars (1871)	718,997	$2\frac{3}{4}$	1,977,242
Sugar (*l*) "	200,000	(*l*) 30	6,000,000
Wheat, bushels	711,000	$11\frac{1}{4}$	7,998,750
Dourra, "	400,000	$11\frac{1}{4}$	4,500,000
Barley, Rice, (*m*) Maize and other grains, bushels	89,000	$11\frac{1}{4}$	1,001,250
Oats, bushels	1,200,000	$12\frac{1}{2}$	1,500,000
Beans and lentils, bushels	1,070,000	2	2,140,000
Dates, cantars	25,000	800	20,000,000
All other, including Mulberry trees, (*n*) Rose-trees, (*o*) poppies, etc	210,224		
Total	4,624,221		

From the above table and the comparative statistics of the exports of cotton and sugar from Egypt, it appears that at the present time the government is encouraging the production of these articles in the place of wheat, and since the area of cultivation is limited, it follows that the product of the latter will be less and less every year. But taking the wheat product at its utmost, what does it amount to? A product of 8,000,000 bushels a year, (*p*) of which 5,000,000 bushels are exported, chiefly to England. In point of fact, however, there have been but six years during the past twenty, when the exports have amounted to as much as 5,000,000 bushels per annum, and there will probably never be another—at least in our days. These years were 1854, 1855, 1856, 1858, 1862 and 1868. In 1864, 1865, 1866 and 1870, there were no exports, on account of famine. In fact, Egypt imported wheat in those years. Last year, 1873, the exports were only $2\frac{1}{2}$ million bushels.

(*l*). This statement of the yield of sugar must be accepted with caution. It is given on the authority of the American consul, but the same authority says that the total product of 1872 was but 1,500,000 cantars. The production of this article is being pushed by the Khédive and more land devoted to it each succeeding year. There are 17 factories in Upper Egypt, capable of turning out 2,350,000 cantars of sugar per annum, and 5 others were building in 1873, with an aggregate capacity of 900,000 cantars.

(*m*). Rice was formerly the principal grain exported from Egypt, but its cultivation began to decline some 50 years ago.

(*n*). There were 10,000 feddans in Mulberry trees in 1837, with 300 trees to the feddan.

(*o*). Mainly in the Faioum.

(*p*). It was about 7,500,000 bushels some ten or fifteen years previously.—Appleton's Encyc.

Conclusion.

When it is remembered that the wheat trade between the United States and Great Britain is an export of 42 million bushels a year from the former, to help supply a demand of 95 million bushels a year on the part of the latter, the utter insignificance of Egypt in this respect and her inability to supply such a material portion of this trade as is likely to have the slightest appreciable effect upon its course or prices, is believed to be evident without any further argument.

Appending, first, the commercial movement of wheat, I will close with a few words relative to the government and the future material welfare of Egypt.

Commercial Movement.

Year.	Exports of Wheat from Alexandria. Bu. (5 to 1 ardeb.)	Received in the United Kingdom Bushels of 56 lbs.	Exports to France. Bushels. (5 to 1 ardeb.)
1833 (*q*)	300,000		
1841 (*r*)	2,493,985	116,430	93,225
1853	4,828,965	3,101,850	
1854	5,078,430	2,625,176	
1855 (*s*)	8,374,260	3,789,422	652,205
1856	7,807,240	4,633,226	
1857	3,762,865	1,770,046	
1858	5,852,240	4,026,982	
1859	2,636,975	3,269,072	
1860	2,823,590	1,717,150	
1861	4,526,200	2,948,960	
1862	6,644,255	6,609,158	
1863	3,896,600	4,645,272	
1864	440,445	734,924	
1865	none (*t*)	20,126	
1866	62,690	67,662	
1867	3,991,010	2,943,512	
1868	5,735,735	6,474,760	
1869	1,844,485	2,040,578	
1870 (*u*)	74,955	213,402	
1871	2,323,345	1,817,694	205,100
1872	4,338,640	4,722,084	121,650 (*w*)
1873 (*v*)	2,500,000	2,543,588	

(*q*). In 1833 the Nile failed to overflow its banks, the harvest was greatly deficient, famine ensued and grain rose to a high price; nevertheless prices were still higher on the Black Sea, and Mehemet Ali, turning a deaf ear to the sufferings of his own people, sent 60,000 ardebs thither for sale.—MacGreggor.

(*r*). In 1841 the exports of wheat from Egypt were mainly to Italy and Turkey. The British trade did not spring up until after this date.

(*s*). In 1855 the exports of wheat were 5,573,070 bushels to Great Britain; 652,205 to France; 137,900 to Austria and 2,011,085 to other countries.

(*t*). In 1865, failure of grain crops. Exports of grain prohibited until July 31, 1866.

(*u*). In 1870, failure of grain crops. Exports of grain other than wheat: Rice 100,625, Maize 6,395 and Barley 170,265 bushels.

(*v*). Wheat shipped from Alexandria to United Kingdom 1862 to 1872 inclusive, 29,352,260 bushels at five to the ardeb. Total received in United Kingdom during same period 30,289,172 bushels of 56 lbs. each—a substantial agreement.

(*w*). 1872. Also 58,855 bushels to Italy.

No wheat is permitted to be shipped from Egypt without paying to the government an export-duty of about 37½ cents per bushel, and no laborer is permitted to leave the country at all; so that the conditions of her industry are in a certain sense fixed.—MacGreggor.

The Future of Egypt.

Apart from the subject of her agricultural and commercial *rivalry* with the United States, Egypt possesses an interest to us which I trust will furnish ample apology for the uncomplimentary terms in which I have found it necessary to advert to her government, or what is the same thing, the Khédive. Rulers have difficulties to contend with which are not always readily appreciated by others, and doubtless the Khédive has his share of them. He sees beneath him a country which demands incessant labor for its cultivation; a people, ignorant, superstitious and, as he believes, slow and lazy. His administration, bad as it seems to us, has nevertheless been one of peace, and wholly unstained by the barbarous cruelties that distinguished those of Mehemet Ali and Ibrahim and Abbas Pasha. But although, to use the expression of the illustrious Turgot with reference to the finance system of France under the reign of Louis XV., the Khédive has not "killed the goose that lays the golden eggs," he has plucked it to the bone.

Were this potentate once to reflect how little glory there is in such a course, and how many millions of suffering human creatures would bless him now and his name forever, did he change it; were he but to consider how infinitely more creditable in the eyes of the world, and more gracious in the sight of the God and the Prophet he worships would appear his devotion to the amelioration of the condition of his people, than the amassment of wealth and the building of palaces in which he is engaged, it is perhaps not too much to say that he would adopt a wholly different national policy.

That this may be the case, and Egypt afforded an opportunity to rise once more among the nations of earth—not as a land merely of archæological remains, but as the abode of a numerous and prosperous people—cannot but be the fervent wish, not only of all Americans, but of the modern world at large.

LIST OF THE NORTH AMERICAN PLATYPTERICES, ATTACI, HEMILEUCINI, CERATOCAMPADÆ, LACHNEIDES, TEREDINES AND HEPIALI, WITH NOTES

By Aug. R. Grote.

(*Read before the American Philosophical Society, Nov. 20th*, 1874.)

In this list, I present the results of my studies on a portion of the North American Bombyces. The admirable synopsis of the Family by Dr. Packard, I have found our best authority on the subject, while I have been able to propose many necessary and important changes in nomenclature from more extended bibliographical researches. The only changes from Dr. Packard's classification here made, are the division of the "Hepiali" into two groups, in which I follow Hübner, and the disintegration of the "Ceratocampadæ" into Hemileucini and Ceratocampadæ indicated by Mr. Robinson and myself in 1866. To Mr. S. H. Scudder we owe the reprinting of the Tentamen of Hübner and, more recently, the discovery of the exact date* (1806) of that valuable document.

In the present List, a star (*) is prefixed where the genus is represented in Europe; a dagger (†) where I have been unable to examine the species myself.

Bombyces Linn. (1788). *Bombyces* Borkh., 1798; *Bombyces* Hübn., 1806; *Bombycites and Noctuo-Bombycites* Latr., 1810; *Phalaenæ* Hübn., 1816.

PLATYPTERICES Hübner (1806).

Platyptericidæ Stephens, 1829; *Platypteryginæ* Grote, 1868.

* Platypteryx Laspeyres (1802).

Type: Bombyx hamula *S. V.*

Note.—Hübner, in his Tentamen, first restricts Laspeyre's generic term to this type. Since Schrank's genus *Drepana* (1801), contains species not congeneric with this type, his name, while earlier, must be used for one of these, and Hübner's restriction of Laspeyre's later term must be respected according to the rules of Zoological nomenclature. This restores my original determination (1862) for our American species. Stephens' "Drepana fasciata," is probably a species of *Drepanodes*, from the description.

siculifer (Pack.), 4th Ann Rep. Peab. Acad. Sci., 87 (*Drepana*); *id.* Stretch, Zyg. Bomb. N. Am., 110, Pl. 4, fig. 11. California.

arcuata (Walk.), C. B. M., 5, 1164 (*Drepana*); *Platypteryx arcuata* Grote, Proc. Acad. N. Sci. Phila., 1862, p. 360; *Plat. fabula* Grote, l. c., p. 59. Canada to Middle States.

genicula (Grote), Proc. Acad. N. Sci. Phila., 1862, p. 59. Canada to Middle States.

* See Hübner, Zutr., 1. S. 4.

* Prionia Hübner (1816).

Type: Phalæna lacertinaria *Linn.*

bilineata (Pack.), Proc. Ent. Soc. Phila., 3, 376 (*Edapteryx*) Pl. 6, fig. 9. Eastern and Middle States.

Note.—Stephens' later restriction of *Platypteryx* for this genus cannot be followed. Möschler, from figures, regards our species as identical with the European. Stett. Ent. Zeit., 251, 1871.

Dryopteris Grote (1862).

Type: Platypteryx formula *Grote.*

rosea (Walk.), C. B. M., 5, 1164 (*Drepana*); *Drepana marginata* Walk., l. c., 1165; *Cilix Americana* H. S, Lep. Exot., 470; *Platypteryx formula* Grote, Proc. Acad. N. Sci., Phila., 1862, 60; *Dryopteris rosea* Grote, l. c., 360. Canada to Virginia.

irrorata Pack., Proc. Ent. Soc., Phila., 3, 377. Eastern States.

ATTACI Linn. (1788).

Note.—This sub-family is indicated by Linné under the name "Attacos," Ed. xiii, Syst. Nat., p, 2401. *Echidnæ* Hübn., and *Heræa* Hübn., must both be considered synonymous. The type of *Echidna* (1803), is *E. Tau;* the type of *Heræa* (1806), is *H. Carpini.*

Actias Leach (1815).

Type: Phalæna Luna *Linn.*

Luna (Linn.), Syst. Nat. Ed. 10, 1, 496, No. 5 (1758); id. Ed. 12, 810, No. 5 (1767); id. Mus. Ulr., 368, No. 5 (1764); Abb. & Sm. Ins. Ga., 1, 95, T. 48; Leach, Edin. Encyc., 9 (1815), (*Actias*); Hübn., Verz., 152, No. 1587 (*Tropæa*). Canada to Alabama; double brooded in Alabama, where it readily flies in the day time.

Note.—The Plate of this species Band 2, Exot. Schm., is wrongly dated "1806" by Packard. It is later than the Verzeichniss. In a letter dated 29th Sept., 1866, Dr. Herrich-Schæffer gave the following dates to the 3d vol. of the Sammlung; "*Casiphone* to *huntera*, 1828; *Asclepias* to *rustica*, 1829; *Io* to *taygete*, 1830; *pasithæ, grimmia*, 1831; *crista* to *beltrao*, 1832; *nesea* to *thirza*, 1833; *debora-hylas*, 1834; *lusca-huebneri*, 1835."

Telea Hübn. (1816).

Type: Bombyx polyphemus *Cramer.*

Polyphemus (Cram.), 1, Pl. 5, A. B.; Fabr., Sp. Ins., 2, 168, No. 5; Mant., 2, 108, No. 6; Linn., Syst. Nat. Ed., 13, p. 2402, No. 461; Fabr., Syst. Ent., 410, No. 8; Abb. & Sm., 93, T. 47; *Telea polyphemus* Hübn., Verz., 154, No. 1610; *Bombyx Paphia*‡ Linn., Mus. Ulr. (1764), p. 369, No. 4, (not S. N. 10, 1758, see Am. Naturalist); *Telea Paphia* Kirby, Trans. R. Dub. Soc., 203 (1872). Canada to Mexico; California.

Attacus Linné.

Type: Attacus Atlas *Linné.*

† **splendidus** (De Beauv.), His. Afr. Am., 133, Pl. 22, fig. 1, 2 (*Bombix*); Clem., Proc. Acad. N. S., Phila. (1860), p. 160, (*Attacus*). Texas.

PHILOSAMIA Grote (1874).

Type: Phalæna Cynthia *Drury*.

NOTE.—Mr. W. F. Kirby, has drawn attention to the fact that after Walker's restriction of the genus *Samia*, in 1855, to *cecropia* and *promethea*, the term could not be used again for Hübner's *Samia cynthia*. The term *Platysamia* must then be dropped and a new name be used for the present genus, hitherto confounded with *Attacus*, and described by me in 1865 under the name *Samia*. To *Philosamia* belong the Asiatic species, *lunula*, *ricini*, *Cumingii* and *Guerini*.

Cynthia (Drury), Ill., 2, 10, Pl. 6, fig. 2; Hübn., Verz., p. 156, No. 1629 (*Samia*); Grote, Proc. Ent. Soc., Phila., 5, 228 (*Samia*).

NOTE.—With the usual latitude for coarseness and infidelity of coloring, I think Cramer's figures under this name represent the same species.

Brooklyn, L. I.; Philadelphia; Baltimore. Introduced and apparently acclimated with us.

CALLOSAMIA Packard (1864).

Type: Bombyx Promethea *Drury*.

Promethea (Drury), Ill. 2, Pl. 12, fig. 1. 2, ♀; Abb. & Smith, His. Ga., 91, T. 46; *Samia Promethea* Hübn., Verz., p. 156, No. 1631; *Callosamia Promethea* Pack., Proc. Ent. Soc., Phila., 3, 379. Canada to Alabama.

NOTE.—In the original perfect copies of Drury, an Index, with names according to the Linnean system, is given at the end of each volume.

angulifera (Walk.), C. B. M., 5, 1224 (*Samia*); Pack., Proc. Ent. Soc., Phila., 3, 380 (*Callosamia*). New York; Pennsylvania.

SAMIA Hübner (1816).

Type: Phalæna Cecropia *Linn.*

Cecropia (Linn.), Syst. Nat. Ed. 10, 1, 496, No. 3; *id.* Ed. 12, 809, No. 3; Mus. Ulr., 368, No. 3; Abb. & Sm., His. Ga., 89, T. 45; *Samia Cecropia* Hübn., Verzeich., 156, No. 1630; *Platysamia Cecropia* Grote, Proc. Ent. Soc., Phila., 5, 229. Canada to Alabama.

† **Columbia** (S. I. Smith), Proc. Bost. Soc. N. Hist., 9, 343. Canada; Eastern States.

† **Gloveri** (Strecker), Lep. Rhop. Het., No. 1, Plate (*Platysamia*). Arizona.

Californica (Grote), Proc. Ent. Soc., Phila., 5, 229 (*Platysamia*); W. F. Kirby, Proc. Roy. Dub. Soc., 1872, 202 (*Samia*); "*Saturnia ceanothi*, Beer," Boisd. Ann. Soc. Ent. Belg., 12, 83.

NOTE.—No description of this species under the names "*Euryalus*" or "*ceanothi*" is known to us previous to Dec., 1865, the date of its description as *Californica*.

California.

* SATURNIA Schrank (1801).

Type: Phalæna pavonia major *Linn.*

† **Galbina** Clem., Proc. Acad. N. S., Phila., 1860, p. 156. Texas.

HEMILEUCINI Grote and Robinson (1866).

NOTE.—This group, which we would consider as of sub-family value, is discussed in Ann. Lyc. Nat. Hist., N. Y. 8, pp. 377, 378. None of the collective names proposed by Hübner can be used. The group is not recognized in the Tentamen (1806); in the Verzeichniss some of the genera are referred to the *Echidnæ*, and one to the *Heræa*, names explained above under *Attaci*.

AUTOMERIS Hübn. (1816).

Type: Bombyx Janus *Cramer*.

Io (Fabr.), Ent. Syst. p. 419, No. 37; Abb. & Sm., Ins. Ga., p. 97, T. 49; Harr. Cat. Ins., Mass. (*Saturnia*); Hübn., Samm. Exot. Sch., 3, figs. 1, 2, ♂, 3, 4, ♀ (*Hyperchiria*); *Hyp. varia* Walk., C. B. M., 6, p. 1278. Canada to Southern States.

NOTE.—This generic term has priority in the Verzeichniss. Cramer's figures under this specific name cannot, by themselves, constitute a valid priority.

Zelleri (G. & R.), Trans. Am. Ent. Soc., Phila., 2, Pl. 2, fig. 65 (*Hyperchiria*). Texas.

COLORADIA Blake (1863).

Type: Coloradia Pandora *Blake*.

NOTE.—This genus is distinct from Dirphia *Hübn.* (1816), the type of which is D. Tarquinius (*Cram*).

Pandora Blake, Proc. Ent. Soc., Phila., 2, 279, Pl. 7. Colorado Territory.

PSEUDOHAZIS G. & R (1866).

Type: Saturnia eglanterina *Boisd.*

NOTE.—Dr. Packard's genus *Eucronia* is founded on H. maja, which we have shown to be Walker's type of Hemileuca. In an opposite view, the validity of the present generic name cannot be disputed until it is satisfactorily shown that the South American *H. venosa* Walk., is congeneric.

Hera (Harr.), Rep. Ins. Inj., Mass., 286, 1841 (*Saturnia*); *Saturnia eglanterina* Boisd., Ann. Soc. Ent. Fr. 2 Ser., 10, 323; *Telea eglanterina* H.-S., Exot., 60, 445; *Pseudohazis Hera* G. & R., Ann. Lyc. N. Hist., N. Y., 8, 377. California; Rocky Mountains.

HEMILEUCA Walk (1855).

Type: Phalæna Maja *Drury*.

Maja (Drury), Ill. 2, 42, Pl. 24, fig, 3; *Bombyx Proserpina* Fabr., Ent. Syst., 561, No. 17; *id.* Abb. & Sm., Ins. Ga., Pl. 50; Walk., C. B. M, 6, 1317 (*Hemileuca*). Mass. to Georgia, Westward to Illinois.

† **Nevadensis** Stretch, Zyg. Bomb. N. Am., 108, Pl. 4, fig. 10. Nevada.

Grotei Hopffer, Trans. Am. Ent. Soc., 2, 192, Pl. 2, fig. 60. Texas.

† **Juno** Pack., 4th Ann. Rep. Peab. Acad. Sci., 87. Arizona.

† **pica** Walk., C. B M., 6, 1318 (*Hemileuca*); G. & R., Trans. Am. Ent. Soc., 2, 74 (*Pseudohazis*). "United States."

EULEUCOPHÆUS Pack. (1872).

Type: Euleuc. tricolor *Pack.*

tricolor Pack., 4th Ann. Rep. Peab. Acad. Sci., 89; Stretch, Zyg. Bomb. N. Am., 143, Pl. 6, figs. 3. 4. New Mexico.

CERATOCAMPADÆ Harris (1841).

NOTE.—This appears to be the earliest collective term that can be used for this group. The genera are partly referred by Hübn. in 1816, to his *Echidnæ* (see *ante*), and partly to his *Trichodæ*. The type of *Trichoda* (1806) is, however, a Lachneid, a designation which has the priority by a line in 1806.

EACLES Hübn. (1816).

Type: Bombyx imperialis *Drury.*

imperialis (Drury), 1, 17, Pl. 9, figs. 1, 2; *Phalæna imperatoria* Abb. & Sm., Ins. Ga., 109, T. 55; Hübn., Verz., 153, No. 1602 (*Eacles*); *Bombyx didyma* De Beauv., Ins. Afr. Am., pp. 51, 52, Pl. 20, figs. 1, 2 (1806). Eastern States, Southward. Appears to be replaced in Brazil by E. magnifica *Walk.*

CITHERONIA Hübn. (1816).

Type: Bombyx regalis *Fabr.*

regalis (Fabr.), Syst. Ent., 436, No. 93; *Phalæna regia* Abb. & Sm., 2, 121, Pl. 61; Hübn., Verz., 153, No. 1599 (*Citheronia*); *Phalæna Laocoon* ‡ Stoll (*nec Cramer*) Supp. pp. 179, 180, Pl. 42, fig. 2, ♂; *Eacles Laocoon*, Walk., C. B. M., 6, 1732. Massachusetts to Georgia. Appears to be replaced in Mexico by C. mexicana *G. & R.*

supulcralis G. & R., Proc. Ent. Soc., Phila., 4, p. 222; Ann. Lyc. N. H., N. Y., 8, p. 382, Pl. 12, figs. 2, 3. Massachusetts to Georgia. This species is represented on one of Abbot's unpublished Plates in the British Museum Collection.

SPHINGICAMPA Walsh (1864).

Type: Sphingicampa distigma *Walsh.*

bicolor (Harr.), Rep. Ins. Inj. Veg., Mass., 203 (1841) *Dryocampa*; Walsh, Proc. Bost. Soc. N. Hist., 1864, p. 293 ♀; *Sphingicampa distigma*, Walsh, l. c. p. 290 ♀ ♂; *Sphing. bicolor* Grote, Soc. Ent. Belg. Comptes Rendus (1874). North Carolina; Illinois; New York.

ANISOTA Hübn. (1816).

Type: Bombyx stigma *Fabr.*

stigma (Fabr.), Ent. Syst., 424, No 54; Abb. & Sm., Ins. Ga., 111, T. 56; Hübn., Verzeichniss, 193, No. 1978 (*Anisota*); Grote, Proc. Ent. Soc., Phila., 3, 93 (*Anisota*). Massachusetts to Georgia.

senatoria (Abb. & Sm.), Ins. Ga., 113, T. 57; Hübn., Verz., 193, No. 1979 (*Anisota*); Harr., Rep. Ins. Mass., 3d Ed., 406, figs. 199, 200 (*Dryocampa*); Grote, Proc. Ent. Soc., Phila., 3, 93 (*Anisota*). Canada to Georgia.

Virginiensis (Drury), Ill., 2, 23, Pl. 13, fig. 2, (*Bombyx*); *Phalæna pellucida* Abb. & Sm., Ins. Ga., 115, T. 58; *Anisota virginiensis* Pack., Proc. Ent. Soc., Phila., 3, 385. Massachusetts to Georgia.

DRYOCAMPA Harris (1835).

Type: Bombyx rubicunda *Fabr.*

rubicunda (Fabr.), Ent. Syst., 429, No. 69; Harr. Cat. Ins., Mass. 72, (*Dryocampa*); Rep. Ins. Inj. Veg. Mass., 3d Ed., 408, fig. 201. Canada to Virginia.

var. **alba** Grote, Bull. Buff. S. N. S., 2, 153. Kansas.

LACHNEIDES Hübn. (1806).

[*Bombycidæ* Stephens (p.), 1829.]
[*Lasiocampidæ* Duponchel (p.), 1846.]

NOTE.—The adoption of this name by Dr. Packard in 1868, must now be followed. It is the earliest title for any part of the sub-family that we are able to find. The type of the genus *Lachneis* is the European *Lachneis Catax.*

GLOVERIA Pack. (1872).

Type: Gloveria Arizonensis *Pack.*

† **Arizonensis** Pack., 4th Rep. Peab. Acad. Sci., p. 90 (1872). Arizona.

* EUTRICHA Hübner (1806).

Type: Bombyx quercifolia *Linn.*

Americana (Harr.), Rt. Ins. Inj. Veg., p. 273; *id.* 3d Ed., p. 377, fig. 176 (*Gastropacha*). Maine to Pennsylvania.

† **ferruginea** (Pack.), Proc. Ent. Soc., Phila., 3, p. 386 (*Gastropacha*). Michigan.

† **carpinifolia** (Boisd.), Ann. Soc. Ent. Belg., 12, p. 83 (*Lasiocampa*). California.

† **Californica** (Pack.), 4th Rep. Peab. Acad. Sci., p. 91 (*Gastropacha*). South California.

† **Mildei** (Stretch), Zyg. and Bomb. N. A., p. 113, Plate 4, fig, 12 (*Gastropacha*). California.

NOTE.—The American species seem to need revision. Dr. Packard informs me that the memoir in which "*alascensis*" was described is no longer extant, the edition having been destroyed in the great fire at Chicago.

* TRICHODA Hübner (1806).

Type: Bombyx neustria *Linn.*

Americana (Fabr.), Ent. Syst., 3, p. 433, No. 81; Harris Rep. Ins. Inj. Veg., p. 269 (*Clisiocampa*); *id.* 3d Ed., Pl. 7, figs. 13, 17; *Cl. decipiens*, Walk., C. B. M., 6, 1488; **castrensis** ‡ Abb. & Sm., p. 119, T. 60; *Bombyx frutetorum* Boisd., Ann. S. E. Belg., 12, 82. Canada to Georgia.

disstria (Hübn.), Verz., p. 192, No. 1975 (*Malacosoma*); neustria ‡ Abb. & Sm., p. 117, T. 59; *Clisiocampa silvatica* Harr., Cat. Ins. Mass., 72; Rep. Ins. Inj. Veg., 271; *id.* 3d Ed., p. 376, Pl. 7, fig. 18, 19; *Bombyx drupaceārum* Boisd., Ann. Soc. Ent. Belg., 12, p. 82. Canada to Georgia.

Californica (Pack.), Proc. Ent. Soc., Phila., 3, p. 387 (*Clisiocampa*); *Bombyx pseudoneustria* Boisd., Ann. Soc. Ent. Belg., 12, 82. California.

ARTACE Walk. (1855).

Type: Artace punctistriga *Walk.*

punctistriga Walk., C. B. M., 7, p. 1491. New York to Georgia.

TOLYPE Hübner (1816).

Type: Bombyx Velleda *Stoll.*

Velleda (Stoll), Supp. Cram., p. 178, Pl. 41, fig. 4; Hübn., Verz., S. 189, No. 1943 (*Tolype*). Canada to Georgia.

Laricis (Fitch), 2d N. Y. Rep. p. 262, Pl. 2, fig. 5 ♂, 6 ♀ (*Planosa*). *Gastr. minuta* Grote, Proc. Ent. Soc., Phila., 2, p. 433 ♂.

NOTE.—Fitch's description and figure of the ♂ were probably taken from rubbed specimens.

HETEROPACHA Harvey (1874).

Type: Heteropacha Rileyana *Harvey.*

Rileyana Harvey. Bull. Buff. Soc., N. S., 1, p. 263, Pl. 11, fig. 1. Missouri; Texas (Boll. in M. C. Z. Cam.).

NOTE.—Dr. Harvey's type is somewhat rubbed. Fresh specimens show the fringes distinctly chequered, fuscous and whitish. On the forewings the median space is darker, confined by dark lines indistinctly edged with whitish. Terminally the wing is more whitish, showing the subterminal spots plainly.

TEREDINES Hübner (1806).

[Cossides *Herr.-Sch.*, 1845.]

NOTE.—This and the following group are equivalent to the "*fodicantes*" of Hübner (1805). We would consider them of equal value. The European *T. Cossus* (Linn.) is made the type of the genus *Teredo*, by Hübner, in the Tentamen. In v. Heineman's extremely unsatisfactory arrangement of the Bombyces, the genus *Limacodes* is associated with this group.

XYSTUS Grote (1874).

Type: Cossus robiniæ *Peck.*

Note.—The name *Xyleutes* of Hübner, cannot be used for this genus, for the reason that it is originally applied to none of the species; in the Verzeichniss it appears to be used instead of *Terelo* (Tentamen) for the European *Teredo cossus* (Linn.). Gr.: ξυστός.

Robiniæ (Peck), Mass. Ag. Rep. Journ., 5, 67 (1818), Plate (*Cossus*); *Harris*, Rt. Ins. Inj. Veg., Mass., 297 (*Xyleutes*); H.-S., Lep. Ex., figs. 170, 171. Canada; Eastern and Middle States; California?

† **crepera** (Harr.), Cat. Ins., Mass., p. 72 (*Cossus*); *Xyleutes crepera* Pack., Proc. Ent. Soc., Phila., 3. p. 388. Massachusetts.

† **querciperda** (Fitch), 5th Rep. Nox. Ins., N. Y., p. 10 (*Cossus*); Pack., Proc. Ent. Soc., Phila., 3, p. 389 (*Xyleutes*). New York.

† **Mac Murtrei** (Boisd.), Icon. Régne. An., Pl. 85, fig. 2 (*Cossus*); *Cossus plagiatus* Walk., Cat. B. M., 7, p. 1515. United States.

† **Populi** (Walk.), C. B. M., 7, p. 1515 (*Cossus*); Pack., Proc. Ent. Soc. Phila., 3, 389 (*Xyleutes*). Hudson's Bay Territory.

NOTE.—A single species is known from Cuba, *Xystus piger* (Grote), Proc. Ent. Soc. Phila., 5, 254 (*Xyleutes*).

* ZEUZERA Latreille (1805).

Type : Bombyx æsculi *Linn.*

† **pyrina** (Fabr.), Ent. Syst., 3, p. 5, No. 6 (*Cossus*); Walk., C. B. M., 7, p. 1530 (*Zeuzera*). North America.

† **Canadensis** H.-S., Lep. Exot. Sp. N. aut In., S. 58, fig. 168; Walk., C. B. M., 7, 1530. Canada (Quebec).

HEPIALI Linn. (1788).

[Hepioli *Hübn.*, 1806.]

NOTE.—This sub-family is indicated by Linné, under the name "Hapiali," Ed. xiii, Syst. Nat., p. 2402.

* HEPIALUS Fabr. (1793).

Type : Noctua humuli *Linn.*

NOTE.—The type of this genus is the European *humuli*, indicated by Hübner in the Tentamen, 1806. Following Dr. Packard's remarks, our species, though occasionally of increased size, do not differ generically.

argenteomaculatus Harr., Cat. Ins., Mass., p. 72; Rep. Ins. Inj. Veg., p. 295; *id.* 3d Ed., p. 410, *partim*. Non alior. Eastern States; Catskill Mts. (Mead.); Pennsylvania (Coll. Am. Ent. Soc., Phila.)

NOTE.—This and the following species have been confounded by Harris and Packard.

quadrigattatus (Grote), Proc. Ent. Soc., Phila., 3, p. 73, Pl. 1, fig. 6 (*Gorgopis*); *Hep. arg.* ‡ Harris, Agassiz, Lake Superior, 389, Pl. 7, fig. 6; *id.* Rep. Ins. Inj. Veg., 3d Ed., p. 410 (foot note), fig. 202; *id.* Walk., *var.* C. B. M., 7, 1556; *Sthenopis arg.* ‡ Pack., Proc. E. S., Phila., 3, 392. Great Slave Lake; Lake Superior; Quebec (Bélanger); Saskatchewan.

NOTE.—This is a larger, more pinkish, salmon-colored species, with smaller dots.

† **purpurascens** (Pack.), Journ. Bost. Soc. Nat. Hist., p. 598 (*Gorgopis*); Pack., Proc. Ent. Soc., Phila., 3, p. 392 (*Sthenopis*). White Mountains, N. Hamp.

† **argentatus** (Pack.), Proc. Ent. Soc., Phila., 3, 392 (*Sthenopis*). Massachusetts.

NOTE.—This is perhaps the true *H. argenteomaculatus*, as separated by myself. Harris first notices apply to an Eastern species.

† **Behrensii** (Stretch), Zyg. Bomb. N. A., 1, 105, Pl. 4, fig. 6 (*Sthenopis*). California.

† **montanus** (Stretch), Zyg. Bomb. N. A., 1, 105, Pl. 4, fig. 7 (*Sthenopis*). California, (Sierra Nevada).

hyperboreus Mösch., W. E. M., 6, 129 (*Epialus*), Taf. 1, fig. 1; *Hep. pulcher* Grote, Proc. Ent. Soc., Phila., 3, p. 522, Pl. 5, fig. 3. Labrador; Colorado Territory.

† **Labradoriensis** Pack., Proc. Ent. Soc., Phila., 3, p. 394. Labrador.

† **mustelinus** Pack., Proc. Ent. Soc., Phila., 3, 393. Eastern States.

gracilis Grote, Proc. Ent. Soc., Phila., 3, p. 522, Pl. 5, fig. 4. Quebec.

† **Californicus** Boisd., Ann. Soc. Ent. Belg., 12, p. 85. California.

† **hectoides** Boisd., Ann. Soc. Ent. Belg., 12, p. 85. California.

RESULTS OF AN EXAMINATION OF AN EXPLODED LOCOMOTIVE BOILER, AND OF EXPERIMENTS TO ASCERTAIN THE CAUSES OF EXPLOSION.

BY DR. CHARLES M. CRESSON.

(*Read before the American Philosophical Society, July* 17, 1874.)

The boiler was constructed of No. 1 ($\frac{5}{16}$) boiler iron, single riveted (with the exception of the junction of the waist with the fire-box, which was double riveted); it was of the ordinary locomotive form with enlarged grate surface adapting it for use with Anthracite fuel.

The fire-box had the ordinary flat crown sheet suspended from wrought iron girders by means of bolts $\frac{3}{4}$ in. in diameter, placed $4\frac{1}{2}$ in. apart, the ends of the girders being supported upon the vertical sides of the fire-box. The vertical sheets of the fire-box were stayed by wrought iron bolts $\frac{7}{8}$ in. in diameter, placed 4 in. apart, screwed into the sheets and riveted at the end.

The crown sheet and that part of the boiler directly over the fire-box were connected by stay-rods.

The engine had been run upon a siding to pull out a train of cars, which train being heavier than was ordinarily pulled, the steam-blower was applied for the purpose of increasing the intensity of the fire and generating steam of a higher pressure than was usually employed. But when preparations for starting were completed, it was found, upon refer-

ence to the time-table, that the engine would have to remain upon the siding until an expected passenger train had passed. The engineer then left the engine, having first stopped off the steam-blower and observed a steam pressure of about 90 lbs. per square inch.

The boiler exploded between ten and twenty minutes after the engineer had left it. The fireman, who had been cleaning the valves of the sand-box, was at work upon the engine when the explosion took place, and when last seen was standing upon the left side of the engine near the donkey-pump, which was used to supply the boiler with water when the engine was upon the siding. The portion of the boiler immediately over and back of the crown-sheets of the fire-box, and including the back dome, was blown off bodily, the line of fracture passing indiscriminately through the seams and across the sheets.

The seams not torn apart were strained in some places as much as $\frac{1}{4}$ of an inch and opened. The fire-box was blown backwards, carrying with it the back tube-sheet. The remaining portion of the waist of the boiler and the engine were driven forward along the track, the tubes remaining fast in the forward tube-sheet. An examination of the fire-box showed the crown-sheet to have been forced violently downwards, one edge crushing the side-sheets of the fire-box, the other edge and the ends of the crown-sheet remaining nearly in place.

Every stay that was displaced was either fairly broken or drawn through the sheets. There were no signs of undue pressure upon any joint or part of the remaining waist of the boiler, excepting at the line of rupture.

The iron in every part of the boiler appeared in good condition, without signs of burning or heating, except in one lower corner of the fire-box, which part, however, was not ruptured or affected by the explosion. Trial pieces of the iron cut from several parts of the fire-box and waist-sheets exhibited good fracture, the lowest tensile strength found was 51,000 lbs. to the square inch.

After a careful examination of the wreck, and of the results of my own experience, I have arrived at the conclusion that the explosion of this boiler was caused by the projection of water upon the heated crown-sheet. The crown-sheet of the furnace was most probably heated to a temperature of between 500° and 600° Ft., in consequence of a neglect to keep the water in the boiler at the proper height.

This temperature, not sufficient to produce a spheroidal state of the water thrown upon the crown-sheet, allowed of enough heat to be stored up and given out suddenly to cause steam of very high pressure to be instantly generated, so that the rear portion of the boiler was blown to pieces before a sufficient time had elapsed to allow of the distribution of the expansive force throughout the waist. By reference to the results of experiments detailed in the following paragraphs, it will be seen that an average of $\frac{73}{100}$ of an inch of depth of water over the crown-sheet could readily be converted into steam in one second of time, and would produce

a pressure of over 570 lbs. per square inch in addition to that already existing in the boiler.

The sudden opening of any outlet of pressure, such as the safety-valve, throttle, whistle, blower or steam-cock to the donkey-pump, would produce a foaming or disturbance of the water-level in the water-space surrounding the fire-box, causing the water to flow over the crown-sheet in an amount quite sufficient to account for the disaster under the conditions indicated.

To illustrate the rapidity of the explosive force, let us suppose the upper surface of the crown-sheet of the fire-box to have been covered with gunpowder to a depth equal to that of the water, which we have shown could have been evaporated by it. If this powder were ignited in the ordinary way, it would require from half a second to two seconds for its complete combustion, according to the quality of the powder, whereas an equal quantity of water thrown upon the crown-sheet could be converted into steam in less than one second, the resulting volume of vapor being nearly equal in both cases.

Careful examination of the quality of the iron, and of the plan of construction of the boiler, have convinced me that the boiler was amply strong for the purposes designed. I am of the opinion that the disaster occurred directly and solely from a neglect to keep the water within the boiler at its proper level.

The tests and experiments made, upon which the foregoing opinion was founded, are as follows :

A.—Tests of Strength of Iron.

Test pieces cut from the worst looking part of the side-sheet of the fire-box gave the following results :

a.—With the length of the sheet. Dimensions of breaking section :

Thickness	0.302 inch.
Width	0.402 "
Original length of piece	2.800 "
After fracture	2.943 "
Length of section extended	1.000 "
Extension	0.143 "
Breaking wt. per sq. in	54,300 lbs.

b —Cut across the sheet. Dimensions of breaking section :

Thickness	0.308 inch.
Width	0.409 "
Original length of piece	2.790 "
After fracture	2.890 "
Extension	0.100 "
Breaking wt. per sq. in	51,200 lbs.
Length of section extended	1.000 inch.

B.—Experiments Upon Hot Plates.

The sampl s employed were cut from the crown-sheet bars of the exploded boiler. To ascertain their specific heat, and the amount of heat they were capable of imparting to water in a given time, the samples were heated in a mercury bath at various temperatures, and then plunged into a weighed amount of water and the rise of temperature carefully ascertained by a thermometer graduated to $\frac{1}{10}$° Ft.

To ascertain the amount of heat imparted by the iron in a given time, the samples were immersed by securing them to a cross-arm fixed to a heavy pendulum of such length as to vibrate in the desired time and averaging the results of many observations.

As these experiments were to ascertain the lowest probable capacity of the iron in the crown-sheet for storing and giving out heat, no great care was taken to prevent radiation of heat from the iron in its passage from the mercury bath to the water, nor of radiation from the water bath during the experiment; the results do not, therefore, by any means, express the full amount of heat to be derived from the samples.

Calculations of the amount of steam generated in a given time by iron under the conditions stated, must therefore fall short of the practical effect produced, and if the conditions assumed for experiment show that steam could have been generated in sufficient quantity and with sufficient rapidity to have destroyed the boiler, we can safely conclude that the actual destructive effect was greater than that expressed by our results.

The specific heat of iron is given in the tables at an average of 0.1200 that is, that eight times as much heat is required to raise one pound of water through a given number of degrees as will suffice to raise one pound of iron through a similar number of degrees. For example, 8 lbs. of iron losing 100° Ft. of temperature will elevate the temperature of 1 lb. of water 100° Ft. By the formula:

$$\frac{\text{Wt. of Water}\left(\begin{matrix}\text{Temp. of Water}\\ \text{before immersion}\end{matrix}-\begin{matrix}\text{Temp. of Water}\\ \text{after immersion}\end{matrix}\right)}{\text{Wt. of Iron}\left(\begin{matrix}\text{Temp. of Iron}\\ \text{before immersion}\end{matrix}-\begin{matrix}\text{Temp. of Iron}\\ \text{after immersion}\end{matrix}\right)}=\text{S. H.}$$

I have determined the specific heat of the sample of iron cut from the boiler to be 0.113 at a temperature of 212° Ft., and as it is considerably greater at higher temperatures, I have therefore assumed it to average $\frac{1}{8}$ that of water.

Experiments made with gunpowder to ascertain the rapidity of explosion, showed that with various kinds of gunpowder the time required for complete ignition of a thin stratum of powder, spread over a surface equal to the area of the crown-sheet, when ignited at one edge only, varied from one-quarter of a second to one and a half seconds; and as the destructive effects are most impressive to the popular mind, they serve to illustrate the effects that can be produced by converting water into steam as the increase in volume is about the same, that is, 1700 volumes of vapor are

produced by the combustion of gunpowder, and 1700 volumes of vapor of atmospheric tension are generated by the conversion of water into steam.

The experiments alluded to of immersing a sample of the iron whilst heated into water, were made chiefly with a sample weighing 2,914 grains heated to a temperature of 500°@520° Ft., and immersed in a body of water weighing 29,140 grains (ten times the weight of the iron). Some of the results were as follows :

Time of immersion	1 second.
Expt. No. 1, rise of temp. of water	2.9° Ft.
" " 2, " " "	2.7° "
" " 3, " " "	2.8° "
" " 4, " " "	2.8° "
" " 5, " " "	2.7° "
" " 6, " " "	2.8° "
" " 7, " " "	2.9° "
" " 8, " " "	2.9° "
" " 9, " " "	2.7° "
Average	2.8° Ft.

Or 2,914 grains of iron were capable of imparting 28° Ft. to an equal weight of water in one second of time.

The weight of the crown-sheet was	300 lbs.
Bars and studs attached was	810 "
Total	1110 lbs.

This mass of iron could therefore impart 28° Ft. to 1110 lbs. of water in one second of time, or could have converted 32 lbs. of water into steam.

For an example, let us suppose the crown-sheet and bars to have been heated to a temperature of 514° Ft., and that we have flowed over it an amount of water sufficient to reduce the temperature of the iron to 423° Ft., corresponding to a pressure of steam of 300 lbs. to the square inch, and which suddenly added to the pressure already existing in the boiler must severely try the boiler, if not tear it apart.

Then, Temp. of Iron	514° Ft.
Reduced to	423° Ft.
Fall of temperature	91° Ft.

Then $1{,}110 \times 91 = 101{,}010$ units of heat given out by the iron; this divided by $8 = 12{,}626$ lbs. of water heated 1° Ft., and this divided by the latent heat of steam at 423° Ft., plus the difference between the sensible heat at 90 lbs. and at 300 lbs. = 913, gives 13.8 lbs. of water as the amount converted into steam at 300 lbs. pressure.

The area of the crown-sheet = 22 sq. ft. this amount of water (13.8 lbs.) would cover it to a depth of 0.12 inches, and when expanded into steam of one atmosphere of tension would occupy a space equal to a prism having the crown-sheet for its base and 204 inches in height. The aver-

age steam space above the crown-sheet is 10 inches, and the compression of the 204 inches of steam into 10 inches would give a pressure of 20.2 atmospheres or 300 lbs. per square inch momentarily added to that of 90 lbs. already existing in the boiler. The cross-section of the strain above the crown-sheet is 42 inches. Thickness of the iron $\frac{5}{16}$ of an inch, or total section of iron to be broken $\frac{5}{8}$ of an inch. Breaking weight from experiment=54.400 lbs. per sq. in.

Then $\frac{54000 \times 5}{\frac{5}{8} \times 42}$ } Breaking strain of perfectly stayed=$\frac{34000}{42}$=810 pounds per sq. in.

Deducting 20 per cent. for rivets=648 lbs. per sq. in., or, according to Fairbairn, deducting 44 per cent. for single riveted joints=454 lbs. for bursting strains.

Let us now suppose the crown-sheet and bars to have been heated to a temperature of 660° Ft., and to be reduced to 485° Ft., the loss of temperature—175° Ft. Then $175 \times 1{,}110 = 194{,}250$ heat units, or $\div 8 =$ 24,281 lbs. of water heated 1° Ft.

Sensible heat of steam at 570 lbs. = ...	485°
" " " 90 lbs. = ...	335°
Difference	150°

This added to the latent heat of steam at 570 lbs. = (777° + 150° =) 927° as the units of heat necessary to convert water at 335° Ft. into steam at 485° Ft.

Then 24,281 ÷ 927 = 26.19 lbs. of water converted. This amount of water would cover the crown-sheet to a depth of 0.228 inches, and would yield an amount of steam of atmospheric tension sufficient to occupy a space equal to a prism having the crown-sheet for its base and 387 inches in height.

When compressed into a height of 10 inches this steam would suddenly add a pressure of 38 atmospheres or 570 lbs. per square inch to the previous pressure of 90 lbs. per square inch, and would give a total pressure exceeding the 648 lbs. per square inch in the maximum of force necessary to tear the boiler apart, as derived from experimental trials of the strength of iron.

I have endeavored by experiment to fix the temperature at which iron, with such a surface as that from this boiler, will produce a spheroidal state in water flowed upon it. When the samples of iron were floating upon boiling mercury (662° Ft.) they failed to repel the water but converted it rapidly into steam.

The specific heat of iron, at high temperatures, averagiag about 0.122, and its specific gravity 7.8, we can assume that an iron plate will raise the temperature of a stratum of water in contact with one surface, and of its own thickness in depth, 1° Ft. for every degree that it loses in temperature, or that it will convert about $\frac{1}{1000}$ of that amount of water at the boiling point into steam of high tension.

The crown-sheet of the furnace of this locomotive, with its stays and girders, weighed 1,110 lbs., and had a surface of 22 square feet, this gives a mass of iron equal to an average of 50.45 lbs. per square foot, or an average thickness of 1.23 inches of iron plate.

Such a plate could therefore raise a stratum of water 1.23 inches in depth 1° Ft. for every 1° Ft. of temperature lost by the iron, or would convert a stratum of water 0.00123 inch in depth into steam.

In our second example, we supposed the temperature of the iron to have fallen from 660° Ft. to 485° Ft., a loss of 175° ; this would give us $0.00123 \times 175 = 0.21525$ inch as the depth of water converted into steam, and which, under the conditions stated, would give a pressure of nearly 37 atmospheres in addition to that already existing within the boiler by the transfer of heat from the iron.

This leads to the conclusion that the substitution of a crown-sheet $\frac{3}{16}$ inch thick, stayed without girders, would require the contraction of the space between the crown-sheet and the roof of the boiler to an average of $2\frac{3}{4}$ inches, to allow of the sudden production of a pressure of steam equal to that capable of development in a boiler constructed as was the one exploded, or the effect of an equally overheated crown-sheet would be reduced to $\frac{1}{4}$ of that which would otherwise have been produced.

That such is the fact was clearly shown by the result of a recent accident to another locomotive in which the crown-sheet was simply forced down, as by a gradual increment of pressure tearing out the stay-bolt and permitting the steam and water to escape into the fire-box and extinguish the fire without further injury to the boiler or engine.

C.—Level of Water in Boilers. (How Affected.)

There are several conditions under which an engineer may be deceived as to the level of the water in the boiler of a locomotive-engine. The most important are :

1. Priming or rise of water-level.
2. Changes of grade.
3. Variations in the speed of the engine.

In all boilers the level of the water is somewhat raised whenever steam is taken off. The amount of the rise is varied by the rapidity with which steam is conveyed away : the form of the boiler and the manner in which heat is applied for the production of steam.

In boilers in which there are narrow water spaces surrounding the fire-box, and those in which heat is conveyed to the water locality, that is, the heating surfaces are small in extent as compared with the whole volume of water, and are very hot, the lift of the water is very considerable whenever an outlet for steam is opened, amounting in some instances to as much as 12 and 14 inches.

In ordinary locomotive boilers the rise upon opening the throttle or safety-valve averages about 4 inches.

The presence of oil in the boiler greatly increases the foaming. The

influence of changes of grade is rarely considered by locomotive engineers. The change from a level road to an ascending grade of 100 feet per mile would cause the water in the boiler to flow back to the fire-box end so as to raise the water-level about $1\frac{3}{4}$ inches, depressing the water-level forward by the same amount or a total variation of $3\frac{1}{2}$ inches.

If the level of the water be found at the top gauge whilst the engine is running with unvarying velocity up a grade of 100 feet per mile, and the engine be stopped upon a descending grade of 100 feet per mile, the actual level of the water over the crown-sheet of the fire-box would be $11\frac{1}{2}$ inches below the top gauge-cock.

If the first observations had indicated one gauge of water only, the actual level of the water, after the engine had been stopped on the descending grade, would be far below the level of the crown-sheet.

From observations made upon an engine by means of a glass gauge on the water column, I have found that the water-level is greatly disturbed during the running of the engine by every change of speed. Whilst at rest the water surface is level; upon starting the engine the water does not take up the motion immediately, but is crowded to the back part of the boiler, and remains so in a greater or less degree until the motion is checked, when the water at first becomes level and then crowds towards the front end of the boiler until the engine is stopped, when its surface becomes level. Running at a speed of about 25 miles an hour, first forward and then backward, the variation at the water-level was about four inches.

D.

A record has been made of the effect of injecting fresh water into boilers containing hot concentrated solutions of various salts; but as analysis of the water supplied to this engine show that they contain but a moderate percentage of salts in solution, it is unnecessary to give the results of the experiments, as the effect produced in practice would add but little to the destructive forces already fully explained, and which are of themselves more than sufficient to account for explosions under the conditions stated.

AN OBITUARY NOTICE OF CHIEF JUSTICE JOHN MEREDITH READ.

By Eli K. Price.

(*Read before the American Philosophical Society, December* 18, 1874.)

It is within the scope of our comprehensive charter to commemorate the life and character of our deceased members. To do so is to promote knowledge, and to render service to science and society. It is thus the dead shall yet speak, and through our press speak to the most intelligent of the civilized world, and to such in future times.

He whose memory we would perpetuate to-night was a most diligent student and able administrator of the science of jurisprudence; that

science without whose protection no other science could be cultivated; nor civilization, or happiness, be maintained among mankind.

John Meredith Read, LL. D., a member of this Society, died on the 29th of November, 1874. He was son of John Read, a former Senator of this State, a member of the Bar, and a long time President of the Bank of Philadelphia; and a grandson of George Read, a signer of the Declaration of Independence and the Constitution of the United States; and Chief Justice of the State of Delaware. Our fellow member was born in this city July 21, 1797, graduated at the University of Pennsylvania, A. B., in 1812; was called to the Bar in 1818. He was elected to the House of Representatives of this State in 1822 and in 1823. He was afterwards City Solicitor and member of Select Council, and in the latter capacity drew up a full and connected account of the finances of the city. Yet later he was successively District Attorney of the United States, and Attorney-General of the State of Pennsylvania. An enumeration of numerous pamphlets containing his reports and arguments may be found in the second volume of Allibone's Dictionary of Authors, under his name.

Long before his elevation to the Bench Mr. Read stood among the leaders of the Bar of Philadelphia, at a period when it was greatly distinguished; when his cotemporaries were the Sergeants, Binney, Chauncey, the Rawles, the Ingersolls, Williams, Meredith, and other eminent counsellors and advocates. His arguments can be here described but by their general characteristics. These evinced the most careful and thorough preparations, both as to facts and law, with an ample brief written by his own hand. From this he spoke with great earnestness and power, with a strong voice. His own strong conviction preceded and was potent for the convincement of court and jury. You never perceived that he spoke because he was employed to speak, but because he felt it his duty to speak; and he no doubt did generally speak according to his actual conviction.

In the celebrated trial of Hanway, in 1851, for treason, Mr. Read was engaged with Thadeus Stevens and J. J. Lewis for the defendant. His preparations for that trial were thorough, and the defence was masterly and successful. In preparation he studied the slave laws of the South, and the law of treason as held in England and the United States. Mr. Stevens afterwards said of that argument. "This speech was never fully reported; if it had been it would have settled the law of treason in the United States for a century." The alleged treason consisted in defending fugitive slaves from capture. Hanway violated the law, but did not levy war against the United States; therefore, did not commit treason.

Though Mr. Read belonged to the Democratic party, he always had a repugnance to slavery; and when the Missouri Compromise was annulled, and that party sought to extend slavery over the territories, it was of necessity that he should soon leave it for the "Free Soil" movement. In a Democratic Convention held in Pittsburgh, in 1849, he offered a resolu-

tion against the extension of slavery, which concluded in these words: "Esteeming it a violation of State Rights to carry it beyond State limits, we deny the power of any citizen to extend the area of bondage beyond its present dominion; nor do we consider it a part of the Constitution that slavery should forever travel with the advancing column of our territorial progress." From that time he became the zealous opponent of the slave power; and when the time came to form the Republican party he was prepared for the work, and from the first, and always, was a supporter of its principles and policy.

Even on the Bench political and Constitutional questions will arise which judges must decide, and will decide according to their political convictions; and this happened several times during the war of the rebellion, when it was in the power of the Courts seriously, if not disastrously, to hamper the action of the National Executive and Congress, for the suppression of the rebellion. In those cases Judge Read was one of the majority of three who uniformly sustained the acts of Congress and the measures of the Government to suppress the rebellion.

When the subject of consolidating the many corporate districts round the old Philadelphia of two square miles into one enlarged city, during the middle years of this century, was agitated, Mr. Read was an earnest advocate for that measure. Though he took no part in framing the new charter, he had prepared statistics of population and finances, which, with the influence of his name, were important to help carry the measure with the people, and the bill in the Legislature.

Mr. Read was elected a Justice of the Supreme Court of Pennsylvania in October, 1858, and commissioned for fifteen years from the first Monday of December of that year. He entered upon the discharge of his judicial duties with an earnest zeal, and performed his full share of the onerous duties of the Court, with exceptions when prostrated by ill health. His opinions are peculiarly characterized by a full history of matters having a bearing upon the cause, and the full citation of judicial authorities applicable to the case. The act of 1810, prohibiting the reading of British precedents, had been repealed in 1836; so that all the investigations and learning of the British Courts were at the service of counsel and the Court. Judge Read, who always desired the fullest light upon the subject of decision, made, while at the Bar, and expected as a Judge, a full citation of the relevant authorities by the counsel, and he carefully availed himself of all that could assist the judgment of the Court. His opinions, therefore, were full of learning, and he brought into our courts, from England and the other States, views and principles that without him would not have enriched our law. His library was extensive, and he kept it furnished with the latest publications; that is, with the most recent editions of elementary law, and the English Reports, and those of other States, as fast as they came from the press.

The opinions of Judge Read ran through forty-one volumes of the Reports; that is, from the 32d to the 73d volume, both inclusive, of our

State Reports. In the first of them we find the evidence of his ardent love of justice, in the severe reprobation of any one being removed from office without notice of the charges made against him, and an opportunity of being heard in his defence. (32 St. R. 478.) In the second of them he delivers the opinion of the Court on the will of Stephen Girard, which decides the city of two square miles to be that preferred in the admission of boys to the College, and that a fatherless child is an orphan within the intent of the will, though the mother be living. It gives the early history of Philadelphia; refers to the customs of London; with a brief biography of Girard, and then he interprets his will, with the aid of lexicons, and Biblical and legal authorities.

Judge Read was always strict in his requirements that trustees should faithfully execute their trusts, both as respects the selection of the proper objects of investment, and as to proper care in making them. (34 St. R. 100.) While he favored the creation of trusts for proper purposes, he was stern in the protection of trust property from insecurity and loss. (46 St R. 494; 41 St. R. 505; 51 St. R. 292.)

As to the power of the United States to levy troops, he held that "Every citizen is bound to serve and defend the State as far as he is capable. No person is naturally exempted from taking up arms in defence of the State; the obligation of every member of society being the same. Those alone are exempted who are incapable of handling arms, or supporting the fatigues of war. This is the reason why old men, children, and women are exempted." (45 St. R. 285.)

His opinion was potential with members of Congress to induce the passage of the act of Congress of March 3d, 1863, authorizing the President, during the rebellion, to suspend the writ of habeas corpus. A letter from Senator Sumner declared his argument conclusive, and it was effective in passing the act.

The labors of the Judge were mostly in the well trodden highways of the law, and his merit consists mainly in knowing well, and keeping to that beaten track. The charm of novelty and new discovery are seldom to reward the industry of the Judge. The merit of adherence to precedents will be easily understood by the layman who has invested the earnings of his life on the opinion of counsel, which opinion must be based on judicial decisions, if succeeding judges can declare the law to be otherwise than it had been held; for such decision pronounces the law for the past as well as for the future, and the citizen may thus lose the law that protected his title by the decision of a cause in which he was not heard. Judge Read was a faithful adherent to established precedent, and hence was an eminently safe and conservative judge.

This is not the place to enumerate the many contributions made by him from the great treasury of British and American law, to the body of the law of Pennsylvania. A notice of a few of these must suffice for an estimate of the value of the judicial services of Judge Read. The profession and the public are indebted to him for the first step made for the

security of title, under our modern acts of limitation, in holding when sitting alone, that a purchaser will be compelled in equity to take a title dependent upon the statutes of limitation for its validity. (6 Pha. R. 185.) One of these statutes removed all exceptions on account of the disability of the claimant, after thirty years' adverse possession. That decision was followed by corresponding decisions by the Supreme Court. (17 St. R. 396; 65 St. R. 55.)

When Pittsburgh City and Allegheny County made default in the payment of their bonds, Judge Read united heartily with his brethren of the Supreme Court to compel those municipalities to meet their obligations, requiring them to lay taxes for that purpose. In his opinion on one of those cases, he says, "Whatever may be said as to the individuality of acts of officers and agents *outside* of their authority is wide of the mark, when attempted to be applied to defective execution within the sphere of authority. The one may be void, but every principle of justice, as every presumption, forbids such conclusion in the other case." Those dealing with officials are not to suffer by their irregularity. "Public business could never be done under such a system. There must be faith in public servants within the scope of their authority, or public business must stop. For defective execution, the public, whose servants they are, must suffer, not innocent parties." (37 St. R. 287–8.)

Judge Read is entitled to especial praise for the part he took in saving special trusts to the jurisprudence of Pennsylvania. Since 1829 a series of decisions made by the Supreme Court had established the law giving validity to special trusts to protect the improvident, helpless, or incapable, by the interposition of trustees. In 1856 there was commenced a counter course of decisions that threatened to deprive parents and benefactors of the power of safely making provision for the unfortunate and helpless. This is a power that all considerate persons would be likely to consider an indispensable one for the welfare of civilized society; yet its existence in our law was threatened. In 1864 the Supreme Court had the opportunity of arresting the downward course of decision, in the case of Barnett's Appeal (46 St. R. 392.), and to Judge Read was assigned the duty of writing the opinion of the Court. He says: "The principal error is in laying down as the law of Pennsylvania, that a trust to receive rents and pay them to another is executed, although not an use executed by the Statute of Uses, but arising from some general principle inherent in the common law of the State. This is not supported by authority." The Judge then proceeds to review the course of decisions prior to the innovations, and restores them into authority; and, with slight modification or exception, these remain in authority down to the latest decision of the Supreme Court. The opinion concludes: "The question then is, shall the settled law of Pennsylvania, as to trusts, remain as it was understood by all our tribunals and the Bar, and had been received since the foundation of the Province to within the last eight years, or are we, without the sanction of the Legislature, entirely to uproot it, and substi-

tute a new system which has been the subject of serious criticism and constant complaint? We do not approve of such judicial legislation, and are therefore of opinion that the Auditor and the Court below erred in declaring that there was no estate vested in the trustees of the testator's will, and, so far, the decree must be reversed." That is, the Court decided that the trustee should hold the title and manage the estate, for the benefit of the beneficiaries; and must hold and protect it upon the trusts specified by the testator.

Another occasion of Judge Read's delivering the opinion of the Supreme Court had a direct interest for this Society; and is also interesting to the science of jurisprudence, though the occasion for its citation as authority may not be frequent. When the square upon which this hall stands belonged to the Commonwealth, the Legislature granted to this Society the perpetual use of this lot for the purposes of this Society, esteeming our objects to be of such public benefit as to comport with those for which the square was held by the State. Though this is a perpetual right in the Society, it was not such a title as could be aliened by the Society to others to be held on other uses, without the authority of the State. This title is, therefore, unique; is unlike any other title in the State. It is a great principle of the common law that titles shall be freely alienable, so that they shall best subserve the interests of civilized society. This is the reason of the rule of law against perpetuities, established by judges who were wisest of British statesmen. The exception allowed by this rule is limited by the duration of designated lives in being and a minority or twenty-one years thereafter. During that period titles may be limited into a succession of limited interests, or clothed with trusts for the maintenance of those deemed incompetent to manage their property for themselves. A special exception was created by the British Parliament, when the nation granted Blenheim and its princely domains to the Duke of Marlborough, to guard the country's gift from alienation by his heirs; and to that immunity it is owing that that splendid castle and domain have not been sold to pay the debts of the heirs of the great Duke. A partial exception exists in Pennsylvania, by an act of the Legislature of 1871 (P. Laws, 879), under which the descendants of the Indian Chief, Cornplanter, now hold their lands in severalty, but inalienably to any but Indians, so that white men may not defraud them, or intermix in the colony. Such a feature should be incorporated into the titles of our Western Indians, when they also shall have lands allotted to them in severalty; a step of progress that must soon be reached if they are to be preserved in existence.

The purpose of the restricted grant to this Society was to preserve the property forever for public uses; for in public and charitable uses lands may be held unalienable in perpeturity. The opinion gives a history of this society, and the following extract will show the grounds of the decision of the Supreme Court, with the friendly estimate of Judge Read, when our library was levied upon for taxes assessed upon the lot and hall:

"It is clear, then, that the Society could not charge this lot by any recognizance, mortgage, judgment, debt, obligation, or responsibility, nor could they create any lien upon it; because it could not be sold by any form of execution, and this being the case, no taxes could be a lien upon it, and no form of proceeding to recover the same could create a lien upon this lot, because it could not be sold under any such judgment. It seems stronger in the case of taxes levied under the authority of the very Government that has expressly prohibited any sale of it, except in the cases specially pointed out, and by the character of its public uses as expressly declared. The uses for which it was given are public, and can neither be affected nor destroyed by the adverse action and process of a court of law. The court below were therefore right, and their judgment must be affirmed.

"This Society numbers amongst its members many distinguished foreigners of great scientific eminence, and it corresponds with public bodies and private individuals devoted to the pursuit of science in every country in Europe; one of its latest correspondents being a Hungarian Society, whose Transactions are published in their native language. It has a most valuable library of about 27,000 volumes, of which a complete catalogue is now preparing at a very heavy expense, including a great many manuscript letters and papers of a most valuable and rare character, relating to the early history of this Province and country. A large number of the works in the library are of a scarce and rare kind, and are not to be found on this side of the Atlantic, including a complete set of the Transactions of the Royal Society of London, commencing two centuries ago. The first President of this Society was the originator of the first fire company, the first public library, the first hospital, and the first academy, now the University of Pennsylvania, a signer of the Declaration of Independence, Minister to France, one of our Ministers Plenipotentiary who signed the provisional articles and the definitive treaty of peace between the United States and Great Britain, and finally one of the framers of the Constitution of the United States.

"This was Dr. Benjamin Franklin, the patriot and the Philosopher; and I cannot but express a confident hope that the City and the State of which he was so distinguished an ornament, will never permit the hands of the tax-gatherer to diminish the fund devoted to the interests of science in every part of the world, both in peace and in war, and belonging to a Society of which he was the founder."

Judge Read, in an opinion concurring with his brethren on the bench, held the Southern Confederacy to be "an entire and complete nullity: The country and the people embraced by this unholy rebellion are simply in a state of rebellion, and are rebellious citizens, but at the same time they are enemies, and may be treated as such. They may be tried as traitors and pirates, and may, under the laws of the United States, be convicted and punished as such, and no man or nation could complain of it as an unjust or illegal act." Yet it was held that we could and should

recognize so gigantic a rebellion as belligerents, from motives of humanity, that the war might be conducted upon the principles of civilized warfare, to prevent indiscriminate slaughter, and that there might be an exchange of prisoners of war. This, he held, might be done without "recognizing the rebel leaders, or their organization, but constantly denying them to be a government *de facto* or *de jure*, or as possessing the powers to issue letters of marque and reprisal, or to fit out privateers, or armed vessels, or to make captures, or to establish prize courts which could condemn as legal prizes the vessels captured by their cruisers." (47 St. R. 180.)

An opinion of the Supreme Court, delivered by Justice Read in 1865, is interesting to science and to every one who travels by railroad. It was a suit by a widow and children against a railroad company for the loss of the life of a husband and father, by alleged negligence, under one of the modern statutes in such case. It is held that at the common law no action was maintainable against a person who caused the death of another; also that *an opinion* of the value of the life lost, by competent judges, is lawful evidence. The loss to be computed is simply that which would be compensatory to the surviving family, in the ability of the deceased to provide for his family. It is therefore held to be a proper inquiry of a witness, from his knowledge of decedent's age, habits, health, and physical condition, how long he would have been useful to his family. From liability for the company's negligence they cannot stipulate for exemption. (51 St. R. 315.) This seems a very mercantile estimate of the value of human life; yet, considering the ready sympathy of juries with the bereaved family, it is the only one that carrying companies can endure and live.

In 1866 several cases involving the validity of the legal tender act, came before our Supreme Court, and its constitutionality was sustained. Judge Read's opinion gives a history of paper money in America. (52 St. R. 71.) In 1819 the Supreme Court of the United States had decided that Congress had the power to create a bank whose bills or notes should be receivable in all payments to the United States. If Congress could do this, the logical inference was that Congress could directly create a currency. In making such issues a legal tender Congress did but what the dependent Colonies had done. The Constitution, while denying the like power to the States, gives expressly to Congress the power to coin money, to regulate the value of domestic and foreign coins in circulation, and, as a necessary implication from positive provisions, to emit bills of credit. Congress was expressly clothed with power to enact all laws necessary and proper for carrying into effect the enumerated powers; and this act was necessary to that end. "This was done at a time and under circumstances which admitted of no other means to carry those great powers into full and effective operation." It was a measure requisite to save the Government and protect the people, in the war of the rebellion; and will be a measure necessary to save and protect them in

all future great wars. Every government must be sufficient unto its own existence; otherwise it must perish.

The Supreme Court of the United States, in 1870, Justice Strong, who had concurred as one of our Supreme Court in the opinion of 1866, delivering the judgment, also decided the validity of the legal tender act. (12 Wal. 457.) That Court held that Congress, besides those specified, had express power to make laws necessary to carry into effect "all other powers vested by this Constitution in the Government of the United States;" and say, "It was certainly intended to confer upon the Government the power of self-preservation." (p. 533.) The import of all the Constitution is to be regarded in the ascertainment of the powers of the Government; and it certainly acquired the universal right of self-preservation. It may not then by self-restrictions and abnegation destroy itself, and thereby fail to fulfill the purpose intended by the American people, and extinguish the fairest hopes of mankind for republican liberty.

In 1867 Justice Read delivered the opinion of the Supreme Court of Pennsylvania, protective of our City's Water Supply, in restraining the pollution of a tributary of the Wissahickon, in which several salutary general principles were applied: No one has a right to foul a stream and make it unfit for domestic use to those below: If the upper riparian owner claims right by prescription he can only succeed for the extent of pollution which existed twenty-one years before: The prescription requires the strictest proof, because it is against common right. The opinion is learned and able. (54 St. R. 40.)

In the same year Justice Thompson and Justice Read wrote concurring opinions, and the majority of the Supreme Court refused the strong remedy of injunction to prevent the running of passenger cars on Sunday. In this case Judge Read uses the language, "We have public squares and a great public Park owned by our fellow citizens, and intended for their benefit, and that of their wives and children. Clergymen, lawyers, physicians, merchants, and even judges have six days in the week in which they may enjoy all these and other advantages, and which they may do cheaply by means of the passenger railways. The laboring man, the mechanic, the artizan, has but one day in which he can rest, can dress himself and his family in their comfortable Sunday clothes, attend church, and then take healthful exercise; but, by this injunction, his carriage—*the poor man's carriage, the passenger car*, is taken away, and is not permitted to run for his accommodation. The laboring man and his children are never allowed to see Fairmount Park, a part of his own property." (54 St. R. 451.)

In January, 1871, the opinion of the Supreme Court was delivered by Justice Read upon the act which authorized the Public Buildings to be erected on Penn Square. Holme's first plan of our City laid out a Centre Square, and one in each of the four angles of the city: the first for buildings of public character, the others to be for the like uses as the Moorfields in London. A history of the location and uses of

Moorfields is given in the opinion, and also that of Penn Square; and the Court had no difficulty in sustaining the validity of the act, as "the Legislature is simply appropriating the square and the streets to the purposes to which the square was originally dedicated." (63 St. R. 489.)

But a few more cases illustrative of the judicial character of Judge Read must suffice. One is a new application of an equitable principle, made necessary by modern legislation, enacted with purpose to favor women's rights. By statute a widow may reject her husband's will, and may elect to take her intestate share in both real and personal estate. Her doing this disturbs the plan of the will, and usually disappoints other legatees. It is just, and so decided by our Supreme Court, that the benefit intended by the will for the wife shall be sequestered to compensate those legatees whom her election has disappointed. (65 St. R. 314.) Again: one under equal obligation to make contribution, as where one co-surety has paid the whole debt, the other is held bound to refund a rateable proportion; but this rule does not hold between joint wrongdoers where one has paid the whole damage, from a policy to discourage such combination to do wrong. But this is confined to cases where the plaintiff is presumed to know that he was doing a wrongful act. Therefore, where a traveller has recovered against one or two counties, bound to maintain a county-line bridge, owing to the bridge breaking down, the county paying the whole damage may recover contribution of the other. (66 St. R., 218.)

A testator must be of sound mind to make a valid will; but if the unsoundness does not affect the general faculties, and does not reach his capacity of testamentary disposition, he may make a valid will. Physicians and unprofessional witnesses may state their opinion of the sanity or insanity of the testator, with the difference that the former are heard as experts. (68 St. R., 342.)

You may perceive from these decisions that a philosophy of practical wisdom pervades the law; and those who know it best are the most ready to assent to the boast of Lord Coke, its greatest ancient authority, when he speaks of "The law, which is the perfection of reason." In it are found the wisdom of all practical life and morals, the rules of conduct, of individuals, society, and governments, and, consequently, it contains the larger and most useful share of the philosophy of the human mind. You have not, therefore, been led into foreign fields, but into those where we should find our more familiar range. The law it is that must preserve the peace and well-being of our race. Its philosophy and progress are worthy the study of the highest intellects. As perfect as Lord Coke thought it, the law has ever since his day been improving towards a higher perfection; and generally the progress has been made in manner to preserve intact the obligation of contracts and the vested rights of property.

When Chief Justice Thompson's term of office expired in December, 1872, Judge Read as senior judge became Chief Justice. This highest judicial office of our State Chief Justice Read held for one year, when his

term expired. For some years his health had been failing, and at times he was unable to take his seat on the Bench, which fact increased the labors of his brethren. At the Bar meeting held for Judge Thompson, after his sudden death while speaking in Court, Judge Read made acknowledgement of the kindness of his brethren. He said: "I have known my deceased friend intimately for fifteen years, for fourteen years of which we were members of the same Court. He was a most kind and considerate associate, and I am personally deeply indebted to him for his thoughtfulness and attention to myself when ill-health called for the indulgence of my brethren. He was a good man, an honest and upright man, an admirable Judge, and a learned lawyer, with great good sense. I was warmly attached to him, and I deplore his loss. I believe every word of the resolutions offered by Judge Porter to be true and eminently just, and a proper tribute to the virtues, talents and great ability of our deceased friend."

Within a day or two after his retirement from office, the late Chief Justice Read called upon the writer of this notice, who had been writing against the new Constitution, and said, "I am again a free citizen, and can speak my mind freely. I also am opposed to this new Constitution, and have an objection to it you have not taken: it is destructive to the secrecy of the ballot." His article appeared December 8th, 1873. The numbering of the voted ticket with the same number set against the name of the voter in the list of voters as required discloses how he voted. The late Chief Justice says, "The freedom of elections depends entirely upon *the ballot* and its *inviolable secrecy*, so that no man shall know how any elector has voted. This secrecy enables all men, in all the walks of society, to deposit their ballots in perfect security that the knowledge of their vote is strictly confined to their own breasts." The officers of election in the State he stated to be 12,795, who know on the night of the has election how every man in the Commonwealth voted. He also takes objection to the great invasion made upon the elector's franchise when there are two candidates, which prevents him from voting *against any* candidate, and makes the voting for the other a useless form. This able article, the last written by him we commemorate, shows his undying love of liberty and justice; his sacred regard for the equal rights of the citizen; his anxiety to protect the humble and poor from dictation and oppression; and his desire to preserve the value of the elective franchise to the citizens.

I would here give the testimony of his associate on the Supreme Bench, Judge Williams, at the Pittsburg Bar meeting, on receiving the news of the death of the late Chief Justice: "He possessed talents and learning of a very high order, and his personal and official influence was very great. He was a gentleman in every sense of the word; a gentleman of the old school, of the very highest sense of honor, of great dignity of character, and in social intercourse kind, affable and courteous." "He had an accurate knowledge of American History, especially of the times

in which he lived, and was familiar with the personal characteristics and history of the men who have been prominent in our State for the last sixty or seventy years, and it was this accurate knowledge which made his conversation so charming and instructive. He was a true friend; strong and unswerving in his attachments; ready to make any sacrifice for his friends, and when in trouble was untiring in his efforts to serve them. He was a man of the strictest integrity, and despised everything that was low and vile. With him the equity and justice of the case *was the law of the case.*" "He was a man of chivalrous courage, persistent purpose and inflexible will. He did not know what fear is." "It is the will power which gives executive ability and persistency of purpose, and enables one to achieve great results. Judge Read had this power to a remarkable degree." Such testimony from such a source is very strong, for judges sitting together for many years, discussing and deciding the many diversified and important cases which come before them, at the same time settling the law of the State, must make them thorough judges of the attainments and qualifications, and of the temper, disposition and self-control of their associates. There is to be added to the above delineation of personal traits, the fact that the characteristic courage and determinate will, were not exercised without the careful research and thought which produced certain belief of rightful action.

The characteristics of Judge Read's judgments were a plain and terse simplicity, without attempt at ornament. It is no exception to this to admit that many of his opinions are long. As a general rule they are short; and when not so, their length is owing to a full history, or statement of facts, and an ample citation of authorities; but all are given in brief language. His practice was to state the facts fully and clearly, and then without process of argument, to apply all the law, British and American, applicable to the facts; and it is at once seen that these warrant the conclusion announced. So conservative was he, that in his hands the law, as well-read lawyers are trained to understand it, was felt to be safe from innovation, while he fearlessly attacked recent innovations, and sought, with large success to restore our jurisprudence to its ancient foundations, except as these had been changed by statute, or the constitutions; methods of progress which could have no retrospective operation to divest vested rights.

Judge Read seemed to have selected no especial branch of the law in which he became more authoritative than in others. His general preparation in all was full; yet he never argued or decided a cause without a special and full study of the case, applying all the proper authorities; hence he was always accurate, and his opinions are mines of erudition for the student, lawyer and judge. In whatever branch of the law the question arose he met and disposed of it with the like able grasp and learning. He was equally familiar with Civil and Criminal law and their practice; with International and Municipal law; with Law and Equity; with the Titles, Limitations and Descents of Real and Personal Estates;

with Wills, Legacies and Intestacies ; with the Constitutions, Charters and Statutes of the United States, the State, and of our Cities. With the Laws, Ordinances and Usages of Philadelphia he was especially familiar. His love for his native city was intense, and he was ever ready to devote his time and talents to her service. His zeal continued to the last ; and he was earnest in his efforts that this should be the place of the Centennial Celebration, and that it should be a great success. His patriotism never grew cold or suffered loss from the chill of age ; but he was always young, progressive and ardent for the progress and improvement of the City. The Park, Public Buildings, and wide well-paved streets, and the water supply were objects of his lively sympathy.

The State and United States, their welfare and prosperity, were also very near to his sympathies, and he was ever alive to all that concerned their well-being and safety. This is shown in all the acts of his life, both as citizen and judge. That he lived and labored in the law as he did, and was the able and patriotic citizen that he was, make the name of Chief Justice Read an honor to his family, his City, his State, and Country, and by them all his memory will be held in respect and honor through future time.

The late Chief Justice Read left to survive him, a widow, and his only heir, John Meredith Read, who ably represented our Country, as Consul General to France, and resided in Paris during her fearful investment by the German armies, in 1870; and who now again represents our Nation as Minister to Greece.

Chief Justice Read lived and died in the Christian faith ; and was ever an opponent of those false philosophies of France, Germany and Great Britain, and more sparcely of our own Country, which seek to undermine the Christian religion ; that religion which gives to life its greatest consolations, and enables man to triumph over the fears of death ; that religion whose immortal faith, alone, gives adequate meaning to the Universe.

ON THE ALLEGED PARALLELISM OF COAL BEDS.

By Jno. J. Stevenson.

(*Read before the American Philosophical Society, Dec.* 18, 1874.)

That coal seams are approximately parallel, is a common belief among persons residing in the coal fields of our country. The more observing of our coal operatives, however, long ago discovered that the assertion of parallelism is a fallacy, and that the interval between any two given beds of coal is liable to vary many feet in thickness within comparatively short distances. So general is this variation that it amounts to a positive law. Until this was accepted as a fact, to the utter exclusion of any notion of parallelism, the coals of southwestern Pennsylvania remained a worse than Chinese puzzle to Geologists, and

every attempt to tabulate them was a failure. For many years the reports of all observers led us to accept the divergence or convergence of coal seams as part of the necessary arrangement of things, a phenomenon quite as ordinary as the occurrence of sandstone or shale in the intervals.

Quite recently, Prof. E. B. Andrews, an assistant on the Ohio Survey, has re-asserted the parallelism of coal-beds, and admits of such exceptions only, as result from the greater or less compressibility of the materials occupying the intervals. He concedes, it is true, that when large areas of any coal field are examined, it may be found that some portions have had a more rapid subsidence than the rest; but he maintains that as a rule the subsidence was so regular that two seams are found to present an almost perfect parallelism. He doubts whether it is possible for a seam to separate into two or more parts, or if separated, for the parts to diverge indefinitely, that is to say, I suppose, for several miles horizontally or to any great extent vertically.

This is no matter of merely theoretical interest. Involving, as it does, not merely the whole question respecting the deposition of coal seams and the intervening rocks, but also, as a consequence, the identification or tracing of the beds over extensive areas, its exact determination is equally important to the economic investigator and to the purely scientific student. It is true, that the question has been a settled one for many years, but long acceptance of a doctrine does not prove its truth. It has been disputed by a Geologist of standing, whose statements deserve and receive consideration. There is need then, that the matter be presented in such a manner as to leave no doubt in the mind of any that the idea of parallelism over even limited areas is utterly fallacious except for rare localities. In geology an erroneous theory is of necessity a pernicious theory.

Coal seams do divide. That is to say, the numerous partings in a coal bed are liable so to thicken as to become distinct strata of shale or sandstone, and in many cases they do so thicken. In his memoir upon the South Staffordshire Coal Field, Prof. Jukes gives an illustration, especially interesting because of the ease with which the bifurcation of the various seams is proved. The coals begin their separation in the southern portion of the field and the divergence continues northward, the coals never coming together again within the area embraced in the memoir. In Plate 1, Prof. Jukes compares two vertical sections, one taken in the south-central portion of the field, and the other in the north-central portion, the distance between them being about five miles. In the first section, which represents a vertical thickness of 350 feet, there are seven beds of coal, each made up of several distinct layers separated by their partings. In the second section, whose thickness is 850 feet, there are eighteen beds of coal, some simple, but most of them compound. The character of the coal from the several seams in the second section shows at once the relation to the beds of the first section.

To give all the details leading to the conclusion offered by Prof. Jukes, would be impossible here. I therefore present only a few sections, showing the variations of a single bed within a limited area, sections obtained in such proximity to each other, that no possible doubt remains respecting the identity of the coals :

	1	2	3	4	5	6
Flying-reed Coal,.....	4′	4′	4′8″	4′4″	2′6″	3′
Interval, ...	0	10′6″	45′9″	55′4″	118′	128′
Thick Coal,.....	25′4″	25′4″	22′6″	24′3″	24′	22′8″

Further sections* show that the *Thick Coal* finally breaks up into nine beds, the whole occupying, with the intervening rocks, a vertical space of 390 feet. The sections given above show that, within a distance of less than one mile, the interval between the two benches of the seam increases from zero or a very thin parting to 128 feet. The extent of area forbids the supposition that this occurred in a petty lagoon. It is, as I hope to show hereafter, in full accordance with the law of coal deposition in our own country.

Other instances might be cited from Great Britain. Thus Mr. Greenough† states that near Ashby de la Zouche, the *bend*, separating the second and third seam of coal, is in the easternmost coal-pits, thirty-three yards thick ; in the next toward the west, twenty-five ; in the most western, only fourteen ; and that in the Budworth Collieries, half a mile further toward the west, it vanishes entirely, the two seams running together. Another instance is mentioned by Capt. Portlock in his report on Londonderry, etc., pp. 600-601.

In our own country, such marked illustrations though rare, are by no means wanting. The bifurcation of the Mammoth Coal Seam is a well ascertained fact and susceptible of absolute proof. At Mahanoy City, Pennsylvania, one of the most important beds divides, and its branches can be traced for a considerable distance, rapidly diverging. On the Great Kanawha River, in West Virginia, as I have shown‡ the celebrated seam worked at Coalburg, shows this tendency to divide. At the east end of the property of the company these partings are thin, rarely exceeding three inches Followed westward, they increase, until at the western boundary of the property the lower one is two feet thick. About ten miles further down the river, three thin coals are found occupying the horizon of this bed. In all probability, they are simply the subordinate coals, separated by the greatly thickened partings. Cases of distinct division of coals, attended by marked divergence of the benches, must

* For the sections given above, see *The South Staffordshire Coal Field*, by J. Beete Jukes. 2d Edition, 1859, pp. 87 and 38.

† *A Critical Examination of the First Principles on Geology*, by G. B. Greenough, President G. S., &c., 1819, p. 22.

‡ Annals of Lyceum Nat. Hist., Vol. X, p. 276.

remain rare in our coal fields until the workings become more extensive and in closer vicinity than now. At present, it is possible only to show the marked changes in the intervals between our coal beds. In doing this, I shall draw all illustrations from the northern portion of the Great Bituminous Trough, which includes Western Pennsylvania.

Lower Coal Group.—The total thickness of this group is subject to great variations. In Pennsylvania it is from 270 to 650 feet; in West Virginia from 200 at the Pennsylvania line to nearly 700 in Randolph County, and nearly 900 on the Great Kanawha, in Ohio from to . In each case the Mahoning Sandstone has been omitted. For detailed examination, I choose the two coals known as the Upper Freeport and Kittanning, in Pennsylvania, and as Nos. VI and IV in Ohio.

Along Yellow Creek, in Ohio, the varying interval between these two coals is finely shown in a continuous exposure from the Ohio River to Irondale, a distance of seven miles. The coals are known locally as the "Big" and "Strip" veins, and between them occurs No. V, locally known as the "Roger." I give only four sections for comparison:

	1	2	3	4
Coal VI	7′	3′7″	5′6″	?
Interval Rocks	16′	60′	60′	100
Coal V	3′	?	2′6″	?
Interval Rocks	60′	52′	65′	60
Coal IV	2′6″	?	2′6″	?

These show a variation from 80′ to 160′ within five miles; the most marked change being in the interval between V and VI.

In Guernsey and Muskingum Counties, Ohio, a much more interesting series of changes occur along Wills Creek and the Muskingum River. This line of section is an important one, as the coals can be traced almost without break. *Coal IV* is accompanied by its Gray (fossiliferous) Limestone, and VI is everywhere seen in the hills. Beginning on Wills Creek, in Guernsey County, about seven miles north from the Central Ohio Railroad, we find near the Salt Works, the two beds 8 feet apart. Somewhat more than a mile further down the Creek, IV is mined by shaft and is 28 feet below VI. Near Liberty, the interval is 40′; at Bridgeville, 105 feet. Still following the Creek and crossing into Muskingum County, we find the interval at Johnson's Mills, 40 feet; at Frew's Mills, 90 feet; at the Salt Works near the Muskingum River, about the same; near Dresden, about 100 feet, and further down the river 110 feet. The line of least interval seems to run northwestwardly through Guernsey County, from the starting point to a little east from Johnson's Mills, the beds diverging on each side of this line. The structure in a cross section is somewhat as appears in this figure, the upper line representing VI, and the lower IV.

At some distance further, northeastward, a similar relation exists between the coals. Across the intervening space VI can be traced quite

readily, but the exposures of IV are far from being continuous, and for miles it does not reach the surface. It is impossible, therefore, to demonstrate the structure, which seems to be as follows :

What the complete structure of the western portion in the first figure may have been cannot be determined, as erosion has removed all the material beyond the Muskingum River. The direct union of the two beds has not been seen, nor is it likely to be seen, since at all localities where the beds approximate they have a heavy cover.

Crossing into Pennsylvania, we take the same beds and carry the section down to the Ferriferous Limestone. The following sections are taken from Rogers' Report *

Upper Freeport C.	3′	3′	—	5′8″	—	—
Interval Rocks	35′	84′	117′	20′	50′	73′
Lower Freeport C.	4′	3′		5′	4′6″	1′6″
Interval Rocks	104′	55′		84′	130′	28′6″
Kittanning C.	3′	3′	3′9″	3′	2′6″	2′
Interval Rocks	25′	30′	33′6″	20′	55′	30′
Ferriferous Limestone	13′	12′	6′6″	8′	6′	8′

In these six sections we find the interval between the two beds varying thus : 184, 143, 142, 117, 109, and 103 feet, while the interval between the Kittaning and the Limestone varies from 55 to 20 feet.

The accessible records of observations in West Virginia are few, but some of them are of interest. In a report upon Property belonging to the Pridevale Iron Company, and situated a few miles above the junction of Cheat and Monongahela Rivers, Prof. W. B. Rogers gives the interval between Upper Freeport and Kittanning, as 160 feet, and between the Kittanning and the Ferriferous Limestone as 50 feet. On Decker's Creek, barely five miles away, I find only 26 feet between the Freeport Coal and the Limestone. The whole group is about 400 feet thick on Cheat river, and only 200 on Decker's Creek. This notable variation occurs chiefly between the upper Freeport Coal and the Limestone, as the section below the latter is substantially the same as both localities.

Going southward, we find the thickness of the whole group rapidly increasing beyond the Baltimore and Ohio Railroad, the Upper Freeport Coal still retaining its proper place under the Mahoning Sandstone, and readily traceable to Randolph County, beyond which I have not followed it. Near the State line at the north, the thickness of the group is 200 feet, in Randolph County it is not far from 700 feet. Whether or not the coal resting on the conglomerate in Randolph County is the same with that resting on the same conglomerate on Decker's Creek, is quite immaterial. It is quite certain that the interval between the conglomerate and the Upper Freeport Coal has increased from 200′ on Decker's Creek, to nearly 700 feet on the Beverly road in Randolph County.

The Upper Freeport Coal itself shows a marked tendency to break up

* Geology of Pennsylvania, Vol. II, Chaps 18, 19, 20 and 22.

and in Upshur and Randolph Counties it does divide. Its partings thicken up and from mere flimsy plates become layers of shale several feet thick, so that the coal usually only three or four feet thick further north, is gradually converted into a mass of shale and coal upwards of twenty feet thick, which at one locality includes a thin layer of sandstone.

Lower Barren Group.—So interesting is this group in itself, and so irregular are its rocks, that it deserves consideration only because it occupies the interval between the Upper Freeport and Pittsburgh seams, two beds, which seem to be the most persistent of all found in the Coal Measures. It is separated into two divisions by a well marked stratum which in Ohio is known as the *Crinoidal Limestone*, and in Pennsylvania as the *Fossiliferous Limestone*. This I have traced from the Muskingum River round through Pennsylvania into West Virginia, where, like nearly all the Coal Measures Limestones, it disappears in the vicinity of the Baltimore and Ohio Railroad, south from Grafton. At the western exposure of the *Pittsburgh* in Ohio, this limestone is 140 feet below it. Northeastward the interval becomes successively 140, 160, 175, 190, 200, and near Steubenville and along the Ohio River 225 feet. In Pennsylvania on the Monongahela River, it is 320, and near Morgantown, West Virginia, 270. In like manner we find a varying interval between it and the Upper Freeport. At the most western exposure of the limestone this interval is 225, further east 280, at its northerly exposure 260, and at Steubenville, on the Ohio, 280 feet. At Morgantown it is 172 feet.

The total interval between the Pittsburgh and Upper Freeport, varies in thickness in Ohio, from 420 feet at the west, to 505 at Steubenville, the increase being regular toward the east. In Pennsylvania it is 200 feet, at Ligonier, 220 at Elk Lick, and on the Monongahela River from 450 to nearly 600 feet. In West Virginia, along the Monongahela and Tygarts Valley River, it varies not much from 420 feet.

Upper Coal Group.—The following table shows the synonyms of the coals of this group.

Ohio.	*Pennsylvania.*	*West Virginia.*
XIII.	Top at Waynesburg.	Not identified.
XII.	Second Waynesburg.	Brownsville.
XI.	Waynesburg.	Waynesburg.
X.	Uniontown??	Absent.
IX.	Absent.	Absent.
VIII*c*.	Absent.	Absent.
VIII*b*.	Sewickley.	Sewickly.
VIII*a*.	Redstone.	Redstone.
VIII.	Pittsburgh.	Pittsburgh.

In this group the wedge shape of the strata is more distinctly shown than in either of the lower groups, partly because of the persistence of the coal seams and partly because of the long continuous sections which can be obtained over a great extent of country. In it too, there is a

nearer approximation locally to parallelism, while at the same time, the parallelism is apparent rather than real, as the beds converge on each side of the trough. So gradual is this convergence, however, that for all practical purposes most of the beds might be regarded as parallel for short distances.

If we ascend the Central Ohio Railroad from the river to the summit, twenty-two miles west, or better yet, ascend Wheeling Hill, on the National Road, four miles from the river, we count nine well-marked beds of coal, beginning with VIII. If we descend westwardly from the railroad summit or from the National Road on the west side of the Wheeling Creek divide, we find only six beds to and including VIII, the topmost bed in each case being XIII. Let us compare the two sections.

	1	2
1. Sandstone, &c.	50′	50′
2. XIII	1′	1′
3. Shale and Sandstone	70′	70′
4. XII	1′6″	1′3″
5. Sandstone	40′	30′
6. XI	2′6″	2′
7. Sandstone, etc.	98′	100′
8. X	3′	4′+
9. Sandstone	35′–40′	40′
10. IX	2′6″	2′6″
11. Limestone and Calc. Shale	70′	70′
12. VIII*c*	4′	0
13. Sandstone	0–35′	0
14. VIII*b*	0–6″	0
15. Limestone	20′–30′	0
16. VIII*a*	1′–6″	0
17. Limestone	12′–25′	0
18. Shale	5′–10′	4′
19. VIII	6′	5′
20. Clay and Limestone	10′	8′
21. Sandstone and Limestone	90′	96′
22. Shales, etc.		46′
23. Crinoidal Limestone		4′

The first section is that obtained on the railroad east from the summit. The second, to No. 21 inclusive, was obtained by descending from the summit across the National Road to Stillwater Creek. Nos. 22 and 23 were obtained on the railroad. This section differs from that obtained on the railroad west from the summit, only in Nos. 9 and 11, which are there 60 and 45 feet respectively, the latter being principally sandstone.*

Respecting the identity of No. 19, in both sections there is no dispute. It is beyond all doubt coal VIII, (Pittsburg). Aside from internal evidence furnished by the seam itself, there is abundant stratigraphical proof of identity. I have traced the bed, with the Crinoidal Limestone

* See Annals Lyceum Nat. Hist., Vol. X, p. 232, where I have described the action of the current causing this alteration,

below, all the way round its western and northern out-crop, from the Central Ohio Railroad to Steubenville, on the Ohio River, and thence down the river to Belleair, the initial point of the first section, where it proved to be the No. 19 of that section. My identification of No. 8, of the second section with No. 8 of the first has been called in question by Prof. Andrews,* who regards the former as equivalent to No. 12 of the Section I. No. 8, of Section II, is known as the Upper Barnesville Coal, and No. 12, of Section I, is the Glenco Coal. As I take it, *Coal X* at Glenco, is one hundred and ten feet above VIII*c* (Glenco), while at Barnesville it is one hundred and five feet above VIII (Pittsburg). There should be no dispute respecting this matter. It is not so complex as to require much skill for its determination. At Glenco, on the Central Ohio Railroad, nine miles west from Belleair, the coals are shown in the hill as in the section on the margin, and hold the same relations as in Section I. VIII*c* disappears under the railroad about two miles west, and IX at about seven. X and XI remain above the railroad to Belmont, 20 miles from Belleair, where the road rises above X. In the meantime XII is caught by the hills near the railroad. We are now seven miles from Barnesville and the railroad summit intervenes. Ascending to the summit and descending thence to Barnesville, we obtain the following sections.

Coal XI.....	—
Interval.....	100′
Coal X.....	—
Interval.....	40′
Coal IX.....	—
Interval.....	70′
Coal VIII*c*.....	—

1. Shales and Sandstones in the Summit cut.		50′	
2. Coal XIII, ...		1′	
3. Shale and Sandstone.....		70′	70′
4. Coal XII.....		1′	1′3″
5. Sandstone and some Shale.....		40′	30′
6. Coal XI.....		2′6″	3′+
7. Sandstone, etc.....		98′	100′
8. Coal X.....		3′	4 +

No. 8 in the second section is the upper coal at Barnesville, and it certainly is the same with No. 8, in the first, which is the one marked X at Glenco, where it clearly lies 110 feet above VIII*c*, the Glenco coal. It is evident then, since X is 110 feet above VIII*c* at Glenco, and 105 feet above VIII at Barnesville, that somewhere between these two points, the strata below No. 11 of Section I, to No. 17 inclusive, of the same section, have disappeared, bringing X about 90 feet nearer to VIII than it is at the river.

But this is not the full extent of this interesting alteration of relations. If, starting from the railroad, we go through Belmont and Jefferson

* See Prof. Andrews' rejoinder to Prof. Newberry, Amer. Journ. Sci., July, 1874.

Counties to the extreme northern exposure of the Pittsburg coal, we obtain a beautiful series of sections fully illustrating the wedge-shape of nearly every stratum between coals VIII and X. In this series *Coal IX* does not appear, as it thins out eastwardly and does not reach the line of section. It is present, however, in the sections, taken four miles west from this line. The localities of the sections are as follows:

1. C. O. R. R. 2. Crossing of Little Short Creek by Wheeling Plank Road. 3. Near Mt. Pleasant. 4. Between Short Creek and Smithfield. 5. Between Smithfield and Little McIntyre Creek. 6. Near Smithfield Station on P. C. & St. L. R. R. 7. Near Knoxville. Of these, the first two are in Belmont County, the rest in Jefferson County.

	I.	II.	III.	IV.	V.	VI.	VI.
1. Coal X	3′	—*	—	—	2½	2½	2½
2. Sandstone	40′	50′	—	—	60′	60′	30′
3. Coal IX	0	0	0	0	0	0	0
4. Limestone and Shale	70′	64′	43′	45′	6′	0	0
5. VIII*c*	4′	1½′	1′	½′	1′	0	0
6. Sandstone	25	20′	18′	20′	8′	0	0
7. VIII*b*?	½′	0	0	0	0	0	0
8. Limestone	30′	15′	15′	8′	0	0	0
9. VIII*a*	1′	1′	⅔′	8″	½″	0	0
10. Limestone and Shale	25′	30′	1½	10′	6′	0	0
11. VIII	7′	5′	5′6″	4′9″	4½	5	4′

The Knoxville section, by Mr. H. Newton, is of further interest in that it shows Coal XI to be only 78 feet above X, whereas, in Belmont County this interval is from 95 to 105 feet. This series shows that the interval between VIII and X, which at the railroad is almost 200 feet, is reduced to only 30 feet at Knoxville, and that the reduction is comparatively gradual, the distance being say thirty miles.

Passing into Pennsylvania I select four sections† from a mass which are equally illustrative, and arrange them, beginning with the most western and going eastward. I take only those showing the relations of the Pittsburg to the Redstone and Sewickly, as the sections containing the higher coals are for the most part imperfect in the lower portion.

1. Interval Rocks	121′+	150′+	30′+	50′
2. Sewickly Coal	6′?	4′	3′	—
3. Interval Rocks	47′	30′	23′	
4. Redstone Coal	—	1½	3′	0 } 40′
5. Interval Rocks	50′	35′	20′	
6. Pittsburg Coal	10½	10′	9′	9′

These seem to show a diminution in the thickness of the intervening rocks toward the east. In connection with the fourth section it may be

* In the Sections, a dash signifies that the exposure is such as not to admit of accurate measurement.

† Geology of Penn., Vol. II, pp. 630, 625, 661, and 651.

well to refer to one given on p. 640, lying much further toward the west. In the latter the interval between the Pittsburg and Uniontown coals is said to be 245 feet, while in the former coal is only about 50 feet above the Sewickly and consequently but 90 feet above the Pittsburg.

In West Virginia the conditions are somewhat peculiar. In the narrow Panhandle at the north, IX and X of the Ohio section are absent. They thin out before crossing the Ohio river, VIIIc. is seen on Wheeling Creek, W. Va., but does not reappear on the east side of the trough. Otherwise the Panhandle section offers little of interest and shows no material variation near Wheeling from that obtained just west from Belleair.

In Monongahela Co., near the State line, we find on the east side of the Monongahela R. the following section: Sewickly Coal, 1 ft.; interval, 40 ft.; Redstone Coal, 4 ft.; interval, 60 ft.; Pittsburg Coal, 6 to 8 feet. On the opposite side of the river, and barely three miles away, the section is Sewickly Coal, 5 ft; interval, 45 ft.; Redstone Coal, 4 ft.; interval, 14 ft.; Pittsburg Coal, lower member, 10 ft. This change results from the disappearance of the heavy sandstone overlying the Pittsburg on the east side of the river.

The limestones of this group disappear somewhat abruptly southward, and give place to shales and sandstones, so that satisfactory sections are by no means frequent. I give for comparison the average sections for Monongahela, Marion Harrison and Upshur Counties:

1. Waynesburg Coal.....	6′ –9′	3′	5′	Not caught by hills.
2. Interval Rocks.....	183′–207′	240′	123′	
3. Sewickly Coal.....	1′ –6′		3′′	
4. Interval Rocks.....	40′ –49′		41′	20′
5. Redstone Coal.....	4′ –5′	2′ –3′	2′ –4′	1′ – 3′
6. Interval Rocks.....	14′ –60′	70′–80′	20′–25′	40′ –60′
7. Pittsburg Coal.....	6′ –14′	8′ –9′	6′ –9′	3′ 9′′–4′

I feel much hesitation in identifying the Redstone Coal in the last section, and think it much more likely to prove the Sewickly. The difference between the Marion and Harrison sections is very marked, the interval between the Pittsburg and Waynesburg being in one case 320′ and in the other, at most, 190′.

Conclusions.—After a careful study of the barren and upper coal groups throughout the northern portion of the great bituminous trough, I am convinced that as a whole the subsidence was regular, approaching uniformity, but that locally there were bulgings or other irreguliarities, such as could not fail to accompany any operations so extensive. The lack of parallelism results from the conditions of deposition, which rendered parallelism impossible. The two groups referred to were deposited in a great trough whose eastern boundary was the Alleghany Mountains; the western, the Cincinnati axis.* They diminish quite regularly in thickness, east and west, from a central area between the Ohio and the Monongahela

* The substance of this portion of the paper was published March 4, 1873, in Annals Lyc. Nat. Hist., Vol. X. pp. 247, *et seq.*

rivers. We may compare each group to an enormous bowl, somewhat elongate and with flattened base.

At the beginning of the upper coal era this trough was a great arm of the sea, closely land locked and communicating with the ocean at the southwest by a comparatively narrow outlet. On the east and southeast sides, rivers brought in their loads of detritus from the highlands to be spread over the bottom, which gradually declined toward the west and northwest. On the opposite shores few streams flowed out, and such as came were sluggish, bearing no coarse material. The place of quiet, pure water is marked by deposit of limestone in the north, while a similar mass, traceable through Ohio southwestwardly, marks the direction of the outlet. The low shore of the southeast is marked by the shallow water detrital deposits and the utter absence of limestones in West Virginia, south from the N. W. Branch of the Baltimore and Ohio Railroad.

The wedge-shape of the rocks intervening between the coals of this group has been shown both in Pennsylvania and Ohio, east and west, as well as in West Virginia, where the tapering is southeastward toward that edge of the trough. The structure of the trough may be illustrated as follows :

Let a basin with gently sloping sides be lined with some black substance ; then filled with some material which will become hard, in which a similar black substance is arranged in layers, some of them covering the whole surface, and others extending only part of the way from the border toward the middle. Now break away the bowl, remove the black exterior to near the base, at the same time cutting off portions of the hardened mass around the border above, so as to give the whole an irregular surface. Here we have a rude representation of the upper coal group, perhaps as good as any that can be made on a small scale. If this mass be divided vertically in two, the face of each piece will rudely resemble a vertical section across the group from Harrison Co., Ohio, to the eastern portion near the Pennsylvania and West Virginia line.

In Ohio, VIII*a*, VIII*b*, VIII*c* and IX are traced directly to where they have disappeared, while X and XI have been found successively approaching VIII. In Pennsylvania similar conditions exist, but the extensive erosion along the Alleghany slopes prevents us giving so full a presentation as that from Ohio. In each case we find the underlying Pittsburg reaching farther east and west than the immediately overlying beds, and continually approaching the higher ones, until, on both sides of the trough, farther study is cut off by the completeness of erosion.

I am, therefore, compelled to believe that *all the coals of the upper coal group are off-shoots from one continuous marsh, which existed from the beginning of the era to its close, and which in its full extent is now known as the Pittsburg Coal Seam.* During the whole time of formation of the upper coal group the general condition was that of regular subsidence interrupted by longer or shorter intervals of repose. During the time of subsidence the marsh advanced up the sides of the trough, as new

land was continually becoming fitted for its support. During repose, deltas were formed in the bay, and the marsh pushed outward on the newly-formed land. If the period of repose were long enough to permit the bay to be filled up, the marsh would cross to the other side if begun on only one, or, if pushing out from all sides, it would reach the centre. The Pittsburg, Redstone, Sewickly and Waynesburg originated at the east, for there they attain their greatest thickness, while westward they diminish. VIIIc. IX and X of the Ohio section are thickest westward and then eastward, the first barely crossing the Ohio river; the others disappearing before they reach it.

It may be objected that a marsh requires an almost level plain for its existence. Nothing could be more erroneous than such a supposition, for all necessary conditions may exist on a hill-side with not too steep a slope. In Colorado, I found on Arkansas Pass, near the head of the Arkansas river, an immense morass covering the whole surface between the cañon walls, a distance of more than one-fourth of a mile. It reaches for several miles down the cañon, whose floor has a fall of nearly two degrees. This is no petty swamp. To all intents and purposes it is a bottomless morass, almost impassable to mounted stock.

There is every reason to suppose that previous to the upper coal epoch, the conditions were by no means so regular throughout the basin. It is highly probable that just before the beginning of that epoch, the trough was narrowed and the eastern border, at least, much raised. Otherwise it would be difficult to explain why it is that the Pittsburg Coal does not distinctly overlap the lower Barren group. At times during the lower coal epoch the folding process must have been carried on quite energetically, much more so than during the epoch of the upper coals. In the latter there are found no subordinate folds such as are exhibited in the former; such, for example, as occurred previous to the formation of the Kittanning so as to produce the secondary troughs in which that coal lies causing so great variations in the thickness of the interval between it and the Upper Freeport. It seems quite possible, judging from some observations in Ohio, that similar subordinate foldings may have taken place previous to the formation of *Coal III*, the next below the Kittanning.

In view of the facts given in this paper, I feel justified in extending my statement that the Indiana and Appalachian coal-fields were not connected during the lower barren and upper coal epochs, by asserting that there is no reason to suppose that they were ever united north from Kentucky. Whether or not they were united farther toward the south must be determined by others.

Thus far no reference has been made to the trough or basin lying east from the Alleghany Mountains and holding the Barren and the Upper Coal Group. The terrific erosion which this region has suffered, only fragmentary areas of coal remaining, renders the collection of details a work of great difficulty, and few observations exist, which bear upon the question under discussion. This basin and the Great Bituminous Trough

seem to have been branches of one great basin during the Upper Coal epoch. They were separated by a tongue of land tapering southwardly and terminating in West Virginia, not far from the Maryland line. The eastern basin rapidly lost its width, and near the union was quite narrow. The relation between the two basins, as I understand it, is rudely represented in the accompanying figure, in which A, is the western, and B, the eastern, which latter now contains the fragmentary areas of semi-bituminous and anthracite coal.

Whether or not this division of the coal-field existed from the beginning of the period, I am unable to conjecture, as my material respecting the Lower Coal Group is not sufficient. But that it had occurred before the formation of the Barren Group admits of no doubt, as that group has a well-defined saucer-shape in the Great Trough, and thickens eastwardly from the dividing area. In like manner the Upper Coal Group thickens east and west from the same region, the Pittsburg, Redstone and Sewickly Coals being as well marked in the eastern basin as in the western.

The eastern basin, as might have been expected, shows little limestone amid its strata. Surrounded on all sides by highlands, it was fed by numerous streams, which brought down sufficient detritus to render its waters turbid throughout. Its mouth was obliterated topographically by the final convulsions of the Appalachium Revolution, so that its precise position is to be ascertained only by close exploration.

The common basin, below the junction of these branches, was broad and never completely filled with detritus so as to permit the marshes to cross it; certainly at no time after the formation of the Pittsburg in that region. This bed cannot be traced across the basin, owing to the fact that it is deeply concealed in the centre, but the Waynesburg and Brownsville thin out rapidly toward the west, and in West Virginia, have almost disappeared before reaching the disturbed region known as the "Oil-break." Limestones are almost unknown, and for four hundred feet on top, the rocks are entirely sandstone and shale, all the limestones and coals belonging to that horizon being absent.

ON EXFOLIATION OF ROCKS NEAR GETTYSBURG.

By P. Frazer, Jr.

(*Read before the American Philosophical Society, Dec. 4th*, 1874.)

During an examination which I made of the Syenite boulders which compose that part of the battle-field of Gettysburg, called the "Devil's Den," (a collection of great blocks of this rock piled one on another in the wildest confusion and lying about $\frac{1}{2}$ mile west of "Granite Spur" or Little Round Top, the ravine where Vincent's Brigade held their ground so manfully on the afternoon of Thursday, July 2, 1863, and

Round Top proper, where the Sixth Corps of the Army of the Potomac intrenched during the night of the 2d and the morning of the 3d,) my attention was directed to a singular example of weathering which was so entirely novel to me, that I determined to secure specimens of it for exhibition to this Society as well as the Academy of Natural Sciences.

It seems to open to me a new view of concretionary structure as well as surface weathering, and is an important item for consideration when the rock is intended for building purposes.

The fracture of these rocks (and indeed of all rocks) should be subdivided into—

1. Fracture on *large* planes.
2. Fracture on small planes.

It is essential to know whether reference is made to large or small planes when the kind of fracture is described in all rocks, for though the general habit of the large plane may be a curved surface where this is shown in the original boulder, the smaller fragments may exhibit splintery, earthy, or any other fracture.

Several of these large boulders are visible in the "Devil's Den," which present 100 square yards or more of surface, and in one or two cases where the fracture seems to have been recent, the surface is very homogeneous, the curve very smooth, and the rock very sound and hard, and with a bluish gray color entirely different from the brown which it assumes in places where it has been more exposed to the weather.

In some of these latter specimens it would be difficult to persuade the eye that the object was not a Cyclopian wall of rounded and square blocks built up by the hand of man, nor is the delusion dispelled by a close examination of the rock. The spaces between the apparently separated blocks are seemingly in need of "pointing up," but otherwise there seems to be a material at the junction different from the mass of the rock.

At one blow of the hammer a shell varying in thickness from $\frac{1}{4}$ to $\frac{3}{4}$ inch and discolored by weathering, though not friable, falls off and the surface beneath is seen to be of normal structure, texture and tenacity.

One curious part of this phenomenon is the tendency of the weathered surface to become conchoidal, even where the face of the rock is plane. It results from the gradual sinking of the outside surface towards the depressions that form the divisions between the separate blocks. The mode of formation of these curious false walls appear to be first, the gradual solutions of parts of the Labradorite matrix between the hornblende crystals.

Certain lines are more readily soluble than others, and these gradually deepen as the troughs that are formed conduct more water over the most yielding parts. The small crystals of hornblende in such troughs after losing their support falls out and are washed away, and at the same time the sides of these miniature troughs being constantly subjected to the solvent action of running water and the trituration of the suspended matter

wear away, forming curved sides deepening towards the axes of the troughs.

As to why the whole texture of the rock should become concretionary and the whole outside surface peel off in one large scale, thick enough to preserve this wall like appearance, I am not know prepared to express an opinion, but hope to be able to submit some hypothesis after further study.

I have observed a similar though not entirely identical phenomenon near the Real Dolores in New Mexico, where an apparently plutonic rock was divided on the exterior in a similar manner, but in this case the whole mass was concretionary.

It appears to open an entirely new question as to whether thick plates of igneous rocks (and *a fortiori* sandstones, &c.,) may not be *weathered* into concretions.

PAH-UTE CREMATION.

(*Read before the American Philosophical Society, Dec. 4th*, 1874.)

READING, Penna., Nov. 25th, 1874.

DR. J. L. LECONTE,

Dear Sir:—In the last issue of the "Popular Science Monthly," I noticed an editorial alluding to your paper upon the subject of "Cremation," as a custom of one of the tribes of Indians inhabiting California.

The same custom prevails amongst that sub-tribe of Pah-Utes, known as the Cottonwood, Corn Creek, Spring Mountain and Pah-rimp Spring Indians. The varying local names are due only to the locality they inhabit, and they are one and the same tribe in reality. While attached to Lt. Wheeler's Expedition of 1871-2, I had ample opportunity to investigate anything pertaining to scientific subjects, and I took special care to collect all facts relating to the habits, customs, and superstitions of the Indian tribes through whose territory we passed.

The tract of country alluded to, as occupied by this sub-tribe of Pah-Utes, lies between 115° and 115°35′ west longitude, and latitude north 35° and 36°. Spring Mountain being their stronghold, and is located just north of the "old Spanish Trail." By means of an interpreter, I obtained the following information. Upon the death of one of these Indians, a pile of wood is prepared in the immediate vicinity; this is so arranged as to form a rectangle, to the heighth of from two to three feet. The corpse is laid upon this, when the fire is started, after which wood is continually thrown across the pile until the body is reduced as much as possible. Mesquite, pine and cedar is usually employed, and forms excellent coals and an intense heat. All the remaining property,—as wearing apparel, arms, blankets, dogs and horse, (if the deceased possessed any)—is also burnt. These last named valuables, I have no doubt,

may be represented to have been burnt, as the number of horses among the tribe is very small. Although, according to their belief, when an Indian dies, his spirit goes to the East, which they consider the "White Man's Hunting Ground," and where he would be unable to hunt, were his spirit deprived of these valuable aids. The remains are then *covered with earth*, whether really *buried* I could not ascertain.

Amongst the Sioux, when an Indian hands to another a stick, it implies a horse, and as soon as the recipient hands the stick to the donor (when at the latter's camp) the horse is given in return. This custom is only observed while a party have collected to dance, and the object is, that when an Indian is rich enough to be able to give away a horse, his vanity is so immense, that he must relate his brave deeds, (Count his Coos) and for the purpose of having at least one admirer upon whom he can depend for applause, and flattering notices, as "How brave!" a noble Dacotah! etc., etc., he looks over the assemblage in a dignified manner and presents some one present with a stick of wood (about a foot in length, and thick as a finger,) for which a horse will be given on the following morning.

A similar custom *might*, partially be used, to, so to use the term, burn a horse in effigy, thereby saving a *poor* tribe a valuable member; for I must say the horses are the better of the two. I have seen and been amongst probably thirty sub-tribes, but the Pah-Utes, of the above named region are the only ones with whom we came in contact, who "Cremate."

Very sincerely,

W. J. HOFFMAN,
103 S. Sixth street.

Stated Meeting, December 18th, 1874.

Present, 17 members.

Vice-President, MR. FRALEY, in the chair.

A letter accepting membership was received from Mr. A. Selwyn, dated Montreal, Dec. 8, 1874.

Letters of acknowledgment were received from the Royal Observatory, at Prag, Oct. 8, (XV, i, 90, 91); the Batavian Society, at Rotterdam, Sept. 26, (89); and the Victoria Institute, London, Nov. 28.

A letter inviting subscription to three sheets of photographic portraits of members of the Hungarian Academy, was received from M. L. Aigner, Buda-Pest.

A letter of envoy was received from the Linnean Society, at Bordeaux.

A letter declining to sit upon the Meunier Committee, on account of necessary and imperative engagements, was received from Prof. Guyot. A similar communication being received from Prof. Cook, the committee was discharged from consideration of the subject.

Donations for the Library were reported from the Royal Batavian Academy and Observatory; the Society at St. Gall; the Revue Politique; Nature; the Meteorological Committee of the R. Society; Essex Institue; Boston Natural History Society, and Mr. Edmund Quincy; Prof. Alfred Mayer; American Chemist; Penn Monthly; Medical News; College of Physicians; College of Pharmacy; Mr. Isaac Lea; Historical Society of Maryland; U. S. Commission of Fisheries; Engineer Department, U. S. A.; and Surgeon General, U. S. A.

An obituary notice of Chief-Justice Read was read by Mr. E. K. Price.

A communication on the alleged Parallelism of Coal-beds, by John J. Stevenson, was read by the Secretary.

The appropriations recommended by the Finance Committee were adopted.

Pending nomination 764, and new nomination 765 were read.

On motion of Mr. E. K. Price, a Standing Committee of Botanists to supervise the purchase and planting of trees for the Michaux Grove, in Fairmount Park, purchased out of the Michaux fund proceeds, was appointed, consisting of five members—Mr. A. H. Smith, Mr. C. E. Smith, Mr. Thomas Meehan, Dr. J. A. Leidy, and Dr. J. L. LeConte.

On motion, a committee of three was appointed to consider the subject of the communication made to this Society by the Baron de la Roncière de Noury, at the last meeting, consisting of Prof. Lesley, Mr. Briggs, and Prof. P. E. Chase.

And the meeting was adjourned.

The following letter furnished for the minutes by Mr. Price, will explain the history of the purchase of the oaks in Europe.

OFFICE OF CHIEF ENGINEER,
OF FAIRMOUNT PARK,
Philadelphia, Dec. 10th, 1874.

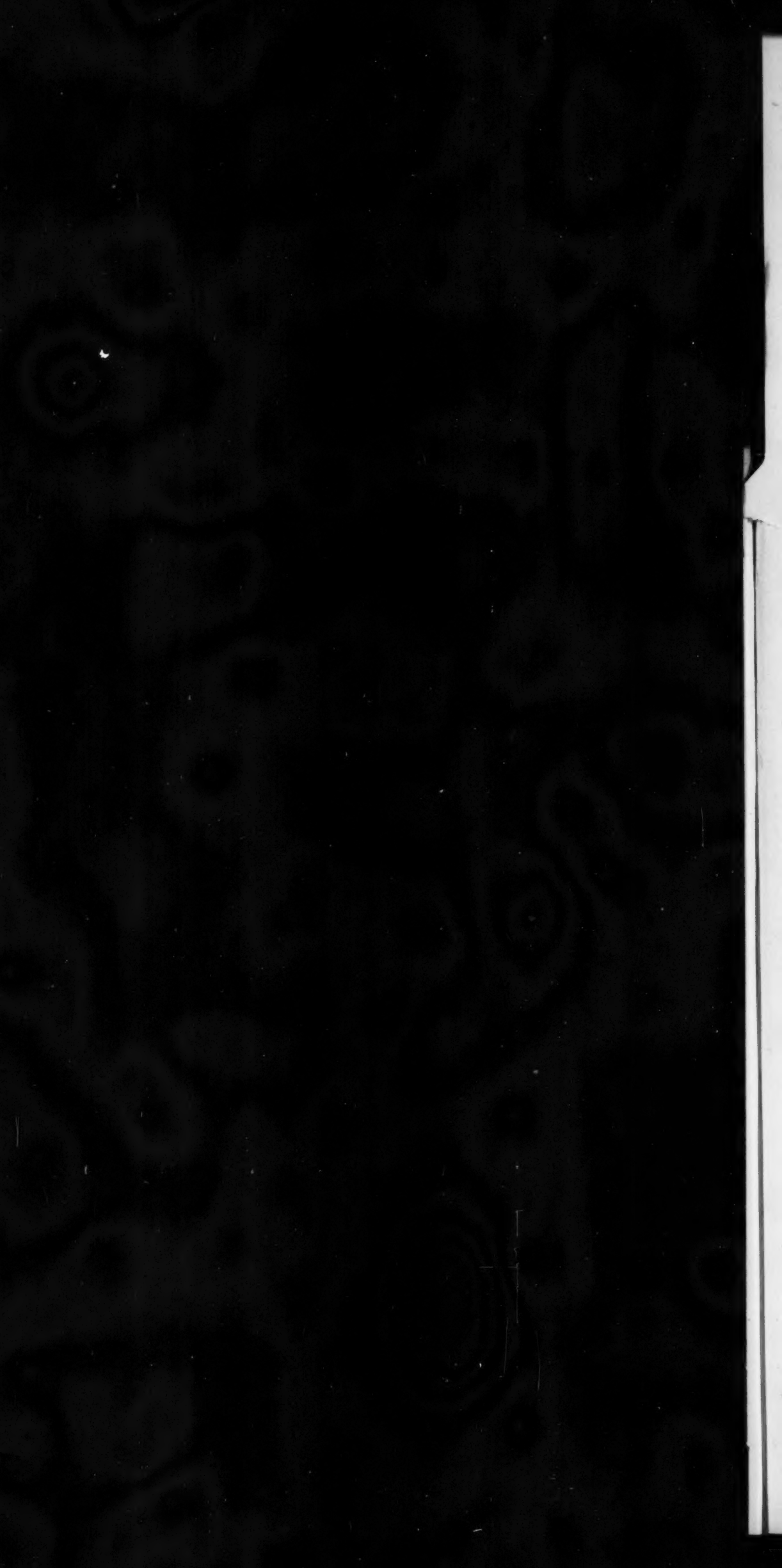
HON. ELI K. PRICE,

Chairman Com. on Nurseries, &c.

Dear Sir:—One of the objects aimed at in establishing the Michaux Grove and Nursery, was to have in the Park not only a school for study, in which might be seen trees, of valuable quality, but also the means of detecting the spurious and unreliable varieties which are sold for pure species. In order to do this, we should be able to show every variety of Oak that will live in this climate, including the sports with the names attached by respectable nurserymen at home and abroad. This is just what I have endeavored to do. Immediately after the resolution by Park Commission, of May 14th, 1870, authorizing the expenditure of $500 for Oaks, several respectable arborists were consulted as to where a collection of Native Oaks could be had, and the result was to get some 12 or 15 species of American Oaks, being all that I found in American Nurseries differing from well-known species already growing in the Park. Several young trees of each of these species were bought and planted on the site selected for a Michaux Grove. Catalogues were then procured from several foreign Nurseries, naming over 100 species and varieties of the genus Quercus. On my visit to England, in 1872, Dr. Hooker, the learned Director of Kew Gardens, was consulted, and several of the largest British Nurseries were visited, and over 80 so-called species and varieties of Oaks were examined. On my next voyage in 1873, other nurseries were visited, and then the first order was given for foreign trees, embracing from 3 to 6 plants of each of some 100 species and varieties and sports, with the names they bore in the catalogues of the most respectable Nurseries. When the invoices were received, it was evident that some of the names were misspelled. As the requisite corrections could not be made at the time, the bills were laid before the Park Commission for payment, the names forwarded in the English invoices were unchanged with the expectation of having the proper corrections made at an early day. The work of correction was commenced, but has been interrupted by my illness, and thus the uncorrected lists were unexpectedly laid before the Philosophical Society. The examinations made during my illness, show that a large proportion of the names are to be found in the list published by Paxton in his Botanical Dictionary, and also in that most complete descriptive work, the Arboretum, of London, and also, elsewhere. While I have been preparing this statement in a condition of great suffering and almost of helplessness from the violence of continued pain, my wife has kindly marked 49 of these identified names with descriptions from which any expert Botanist may recognise the plants. This work of identification, Mr. Estabrook is quite willing to undertake as soon as the spring shall bring out the foliage.*

Truly yours,

JNO. C. CRESSON, *Chief Engineer.*



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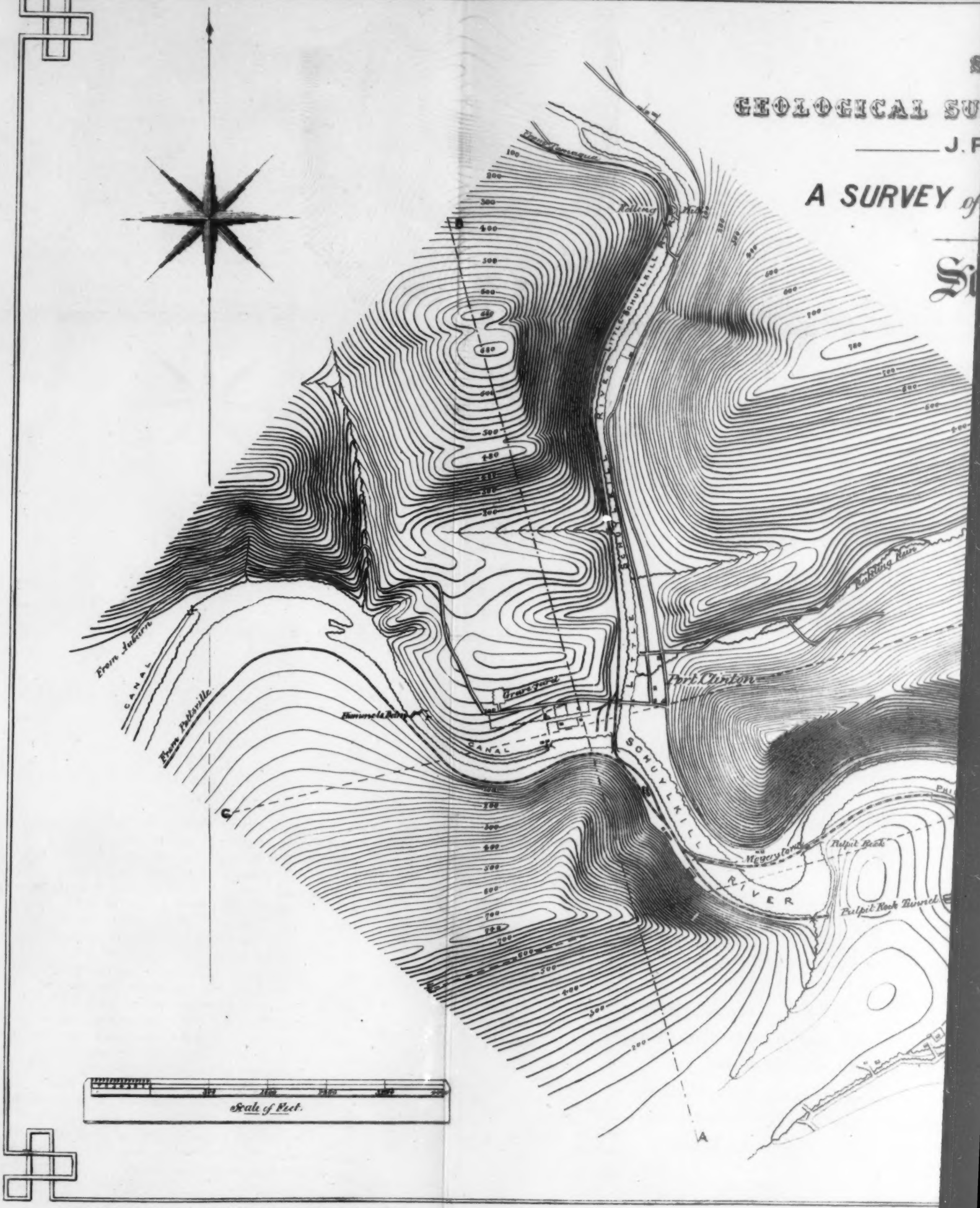

PHOTO-ZINCOGRAPH by F. A. WENDEROTH & CO., 1328 Chestnut Street, Philada.

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Showing the Pulpit Rock

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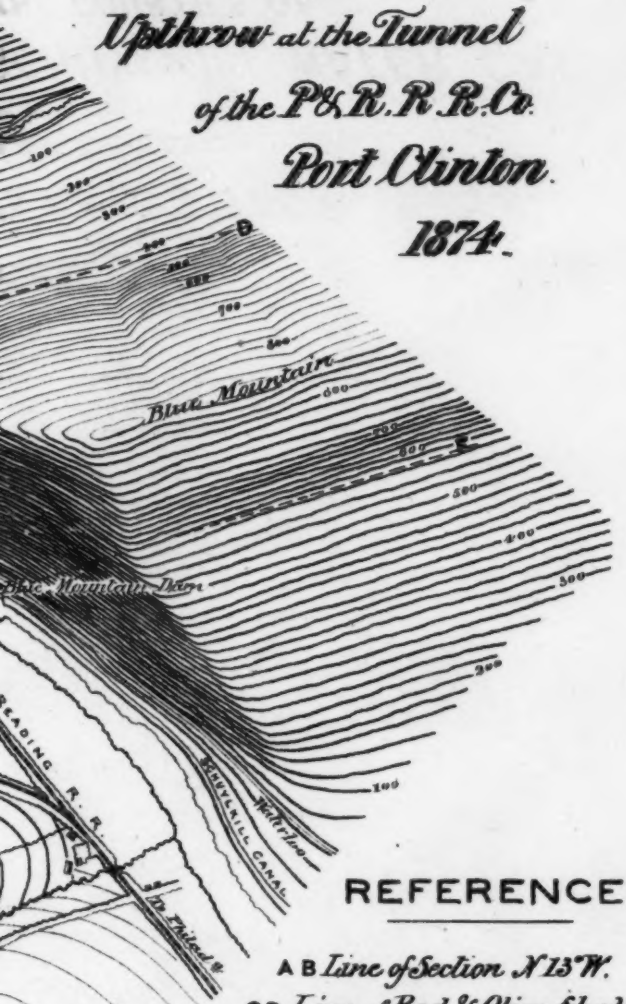

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A B *Line of Section N 13° W.*

C D *Line of Red & Olive Shales.*

E F *Line of Upthrow.*

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Add 352 feet for elevation above T.

H. M. Chance Volunteer Asst